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Access, successful completion and learning achievement of female undergraduate students studying mathematics at the University of Education, Winneba

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Abstract

The study aims to describe gender inequalities in female participation in mathematics education in the University of Education, Winneba (UEW). The study investigated, particularly, the trends in access and successful completion (of female undergraduate students studying mathematics in UEW from 2009 to 2018. The study was based on quantitative secondary data extracted from the university's admission and graduation records. The study therefore employed the methodology of secondary data analysis (SDA) which was adopted to replace the original questionnaire survey research which had to be abandoned as a result of the COVID-19 lockdown of the institution for nearly one year. A template was developed to capture the data from the UEW Planning Unit and others were obtained online from statistical publications to authenticate the Planning Unit data. The main findings of the study were that the trend in access for qualified undergraduate students provided by the Mathematics Education Department has been consistently high (i.e., nearly all qualified female applicants were admitted). But the proportion of female applicants ranged from 6.2% to 14.2% with a mean of 8.9% of the total applicants. The proportion of undergraduate female students actually graduating was consistently high with the females usually obtaining the middle grades (i.e., no Pass or First-class grade). It is recommended that the Department, and for that matter the University, embarks on an admission drive at the senior high school level to sensitize female students to select mathematics education for their tertiary education.

Keywords: female access; completion rate; mathematics education programmes; gender inequalities; learning progression

Introduction

Higher education in Ghana has recently seen remarkable growth in various frontages such as widening access and participation, expansion of academic facilities, transformative policies, innovative funding approaches and many others. Report from Institute for Statistics (UIS) of United Nations Educational, Scientific and Culture Organization (UNESCO, 2009) indicates that there has been an increase in the participation of higher education in Ghana. For instance, an enrolment rose by an annual growth rate of ten percent (10%) between the year 2000 and 2005. Nevertheless, there remains inequality of gender participation in Ghanaian higher education. The participation rate of males

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continues to surpass those of females. Atuahene and Owusu-Ansah (2013) argue that inequality also persists in the program that a student pursues in higher education, the disparity rate between the percentage of students enrolled in the Arts-and Humanities related programs and those in science, technology, engineering and mathematics (i.e., STEM) programs is very high. Learning progression which is the act of moving forward in educational courses by both genders shows a negative trend for STEM programs. Impliedly, out of the few females who get the chance to enter into higher education in the country, the majority of that population are likely to join the traditional disciplines leaving the STEM disciplines for only a few females and the dominating males to pursue these programs.

Inequalities in higher education courses is problematic; disciplines are selected based on gender, with regards to the society's preferences in students' choice of program of study which in turns favour males and, has resulted inequalities in STEM disciplines. There is still a traditional view that STEM subjects require physical strength failing that there is the interpretative for cognitive strength. This has affected the capability and competency in women, since they are branded as inferior scholars, incapable of reason, abstraction and disembodied and making more women lacking the necessary attributes to succeed in life. It is acknowledged that in some countries, females have gained ground in mathematics. For example, high school females in the United States favourably compare with males in classroom grades and the amount of completed mathematics coursework. Nonetheless, Ghana's situation is different.

In higher institutions, mathematics related courses are dominated by males. The few females among the mathematics class fail to live up to expectation. Several researchers have found initial or increasing gender differences in performance and particularly in women with a middle grade or higher (Blue and Gann 2016; Halpern, Wai, & Saw, 2005; Lawhead, Loyd, Schep, Laws, & Price, 2005; Ma and Cartwright 2003; Penner and Paret 2008). Currently, women have significantly increased their participation in jobs and higher education, but the gap in universities and choices continues to be evident. The population of Ghana is female dominating according to the 2010 Population and Housing Census (PHC) report by the Ghana Statistical Service (GSS, 2012). The report stated clearly that the twenty-four million, six hundred and fifty-eight thousand, eight hundred and twenty-three (24,658,823) females consists of twelve million and twenty-four thousand, eight hundred and forty-five (12,024,845) males representing 48.8% and Twelve Million, Six Hundred and Thirty-Three Thousand, Nine Hundred and Seventy-Eight (12,633,978) females representing 51.2%, (GSS,2012). The disparity and inequality in gender emanates more as students climb the academic ladder (UNESCO, 2012). For instance, in 2010, the GSS identified gender gap in the study of Mathematics education in our secondary schools and universities to be 50.8% and 44.9% for males and females respectively. The findings further revealed that the rate of increase for the population aged between eighteen- and twenty-one-years pursuing mathematics at the tertiary level within the same year is 10.8% for males and 7.5% for female (GSS,2012). What this means is that the rate of females' enrolment in mathematics education at the tertiary level is relatively less than their male counterparts.

The situation is not different at University of Education, Winneba (UEW). There is a big gap between the number of male and female students admitted to pursue Mathematics

courses. Whether the few female students admitted to do Mathematics are able to progress to the final year and complete with good GPAs is also another question to be answered. The study was guided by the following questions:

1. What is the trend in access of female undergraduate students who studied mathematics at University of Education, Winneba, in the decade from 2009-2018?
2. What is the trend in the successful completion of female undergraduate students who studied mathematics at the University of Education, Winneba, in the decade from 2009-2018?

Research Method

Research Design

A secondary data analysis (SDA) methodology was used in this study. This was largely because the data required to answer the questions in this research are secondary data. The quantitative secondary data used was restricted to only university students' admission and graduation records.

Instrumentation

The researcher was working on a secondary data which can be interpreted well using templates. The data captured with the templates were explored to answer the research questions. A template was developed to capture the data on the subjects who applied and actually studied mathematics education at the university from 2009 to 2018 (see Appendix A). Another template was designed to capture subjects admitted who progressed to graduate in mathematics education from 2013 to 2019 (see Appendix B).

The templates were used by the researcher to interpreted secondary data for the study to better understand the problem at hand. Most of the data were obtained from the UEW Planning Unit and others were obtained online (UEW website) from statistical publications to authenticate the Planning Unit data. Secondary data are already existing data and involve research materials published in research reports and similar documents. They can be made available by public libraries, websites, surveys, journals, books, magazines, etc.

Participants

The population of a study according to Bryman (2008) is the universe of units from which the sample represent. The targeted population of the study was made of all female and male mathematics graduates from public universities in Ghana. The accessible population of the study included male and female students from University of Education, Winneba with emphasis on females studying mathematics education. The population comprised all 3,015 undergraduate candidates (i.e. 2766 males and 249 females) who applied to study mathematics education at the University of Education, Winneba, from 2009 to 2018. Specifically, the population covered the following categories: (i) applications received, (ii) qualified applicants, and (iii) applicants actually admitted.

Convenient sampling approach was employed by the researcher population include all subjects of the population in study because the researcher is a student of mathematics education. In this study, the population was used as the sample (i.e., census sample) since the former was not large making the sample highly generalizable. Also, Zamboni (2018) contends larger sample sizes allow researchers to have samples that are representative.

The convenient sampling approach was used because the study was being carried out in the Department of Mathematics Education of UEW and the researcher is familiar with the structures of the institutions, and for that matter, found it easy in obtaining and interpreting the required information from the

Planning Unit. Also, because the university's responsibility is on teacher education and the production of professional educators to spearhead the nation's development.

Results

This chapter presents and discusses the results of the study. It presents the analysis of the secondary data gathered from the Planning Directory of the Registry of the University of Education, Winneba (UEW), on undergraduate students' access, progression and attainment from 2009 to 2018 in the Department of Mathematics. The purpose of the research work was to investigate the trend in access, progression and achievement of female undergraduate students studying mathematics in a decade at UEW. The data obtained were organized and presented using charts, descriptive statistics and inferential statistics including independent sample t-test. The results are presented and discussed in this chapter according to the research questions:

What is the trend in access of female undergraduate students who studied Mathematics at University of Education, Winneba from 2009 to 2018?

The decade 2009 to 2018, had seen hundreds of students (i.e. males and females) studying in the Mathematics Department. Table 1 shows the number of students enrolled in the Mathematics Department by gender.

Table 1 Distribution of students enrolled in the Mathematics Department by gender in the decade 2009 to 2018

Academic Year	Total	Male (%)	Female (%)
2009/10	192	178 (92.7)	14 (7.3)
2010/11	186	171 (91.9)	15 (8.1)
2011/12	157	149 (94.9)	8 (5.1)
2012/13	207	192 (92.8)	15 (7.2)
2013/14	234	209 (89.3)	25 (10.7)
2014/15	187	170 (90.9)	17 (9.1)
2015/16	220	192 (87.3)	28 (12.7)
2016/17	322	290 (90.1)	32 (9.9)
2017/18	191	174 (91.1)	17 (8.9)
2018/19	480	410 (85.4)	70 (14.6)
Decade Total	2376	2135 (89.9)	241 (10.1)
Decade Annual Average	-	90.6	9.4

Source (UEW Planning Unit, 2018)

Table 1 shows that in the decade under consideration, the Department of Mathematics Education, UEW, had admitted 2376 undergraduate students with 2135 (89.9%) males and only 241 (10.1%) females. The lowest number of students admitted in the decade was 157 in 2011 and the highest was 480 in 2018. The proportion of female undergraduate students admitted in the department each year rose from 5.1% in 2012 and increased gradually to 12.7 in 2016 and reached 14.6 in 2018. The average percent of female undergraduate students admitted in the

department was 9.4% in the decade while the majority (90.6%) were males.

The fact that the average percent of female undergraduate students admitted in the department had been consistently low over the decade had provided the spur for this study to investigate the trend in access, progression and achievement of female undergraduate students studying mathematics, the factors influencing this trend and to explore measures that the department can put in place to ensure a good gender balance in admission of undergraduate students.

What is the trend in successful completion of female undergraduate students studying mathematics in the University of Education, Winneba, in the decade from 2009-2018?

According to the UNESCO (2017) report on girls' and women's education in STEM, gender gaps in participation become more obvious in higher or tertiary education. The report pointed out that female students represent only 35% of all students enrolled in STEM-related fields of study at the tertiary education level globally. But the big question is whether or not Department of Mathematics, UEW, is making enough progress to ensure the admission rate of female undergraduate students studying mathematics falls in line with international trends in female enrolment in STEM-related fields. To explore this question, the present study focuses on differences in gender of undergraduate students obtaining access to pursue mathematics education programme in the Department of Mathematics, UEW, over the decade from 2009 to 2018. The concept of access to education has been addressed from several perspectives, but for purpose of the present study, access is perceived in terms of the number of potential students entering higher education. Data used for the analysis of access were numbers obtained annually on (i) applications received, (ii) qualified applicants, and (iii) applicants actually admitted. Table 2 shows the distribution of qualified applicants, that is, those whose qualifications met the entry requirements for BSc mathematics education programme and those who were actually admitted.

Table 2 Distribution of qualified applicants and those actually admitted

Academic Year	Applicants			Qualified		Admitted	
	Total	Males (%)[1]	Females (%)	Males (%)	Females (%)	Males (%)	Females (%)
2009/10	258	242 (93.8)	16 (6.2)	178 (73.6)	14 (87.5)	178 (100)	14 (100)
2010/11	282	261 (92.6)	21 (7.4)	249 (95.4)	20 (95.2)	171 (69)	15 (75)
2011/12	260	243 (93.5)	17 (6.5)	197 (81.1)	8 (47.1)	149 (76)	8 (100)
2012/13	300	281 (93.7)	19 (6.3)	273 (97.2)	15 (78.9)	192 (70)	15 (100)
2013/14	348	317 (91.1)	31 (8.9)	291 (91.8)	26 (83.9)	209 (72)	25 (96)
2014/15	267	229 (85.8)	38 (14.2)	192 (83.8)	17 (44.7)	170 (89)	17 (100)
2015/16	396	353 (89.1)	43 (10.9)	349 (98.9)	29 (67.4)	192 (55)	28 (97)
2016/17	721	651 (90.3)	70 (9.7)	338 (51.9)	33 (47.1)	290 (86)	32 (97)
2017/18	394	372 (94.4)	22 (5.6)	289 (77.7)	17 (77.3)	174 (60)	17 (100)
2018/19	697	607 (87.1)	90 (12.9)	410 (67.5)	70 (77.8)	410 (100)	70 (100)
Average %		91.1	8.9	82	71	77.7	96.5

Source (UEW Planning Unit, 2018); [1]Percentage of applicants in parenthesis.

From the Table 2, it can be seen that both male and female students are applying to offer mathematics in the Mathematics Department. The dominant group of the applicants are males within the decade of 2009 – 2018 academic years of the study. Also, looking at the qualified number of applicants, which means those who met the cut-off aggregate of the university, it can be seen that not all applicants (both male and female) met the university's cut-off aggregate and almost all (i.e., an average of 97%) of the females who qualified are admitted into the Department of Mathematics Education.

It can, therefore, be argued that the department provided access for nearly all qualified female applications that applied for admission in the decade under consideration. Access in education means the ways in which educational institutions and their gender policies ensure or at least strive to ensure that students have equal and equitable opportunities to take full advantage of their education. Increasing access generally requires institutions to provide additional services or remove any actual or potential barriers that might prevent some students from equal participation in certain courses or academic programs (fletcher, 2009).

Figure 1 shows the trend in access provided by the Mathematics Education Department for female undergraduate students to study mathematics education in the past ten years juxtaposed with the total female applicants to the department's programmes. The figure clearly shows that, in decade under consideration, the trend in access for female undergraduate students provided by the Mathematics Education Department has been consistently high.

However, major barrier preventing the equal participation of female students in the department is the low application rate. That is, the number of females actually applying offer Mathematics Education programmes in the

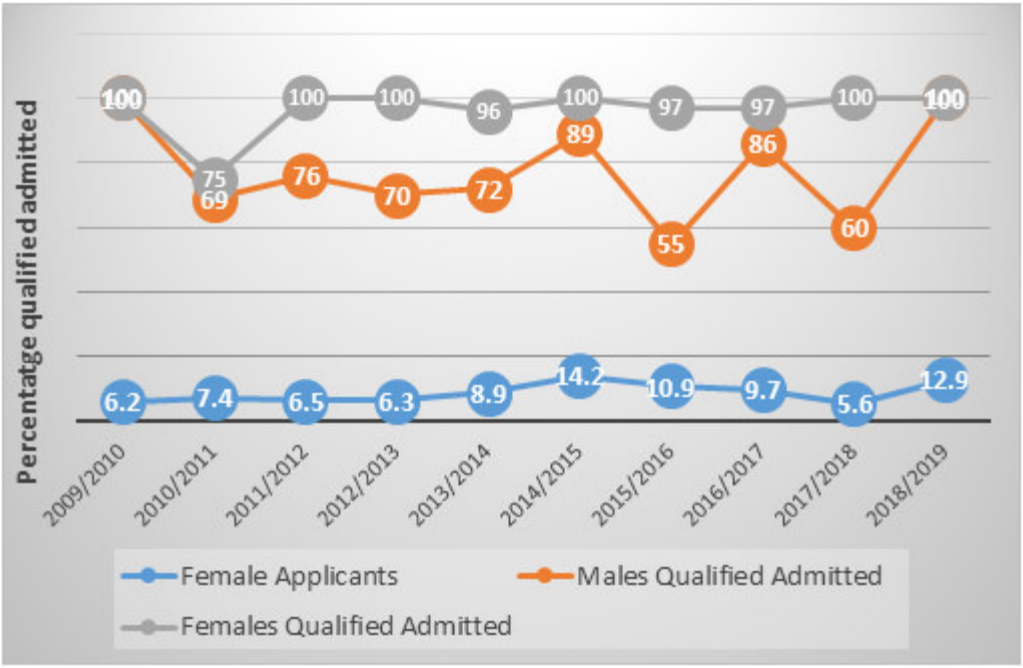

Figure 1 Trend in access of undergraduate female students provided by the Mathematics Education Department from 2009 to 2018

Department is not encouraging. Table 4.2 and Figure 1 show that the proportion of female applicants range from 6.2% to 14.2% with a mean of 8.9%. These imply the Mathematics Education Department has made very little effort in the decade to deliberately increase the number of female applicants to the department's programmes to ensure equal gender participation. There is a need for the department to put in deliberate measures to increase female applicants to its programmes to meet the university's gender parity aspirations.

What is the trend in the successful completion of female undergraduate students who studied mathematics at the University of Education, Winneba, in the decade from 2009-2018?

The researcher in this study was interested in finding out the number of female students that the department is capable of retaining till graduation (or retention). The proportion of students who persevered and successfully completed the programme out of the number admitted was used as proxy measure for female undergraduate retention on the programme. Table 3 shows the number (and proportion) of students admitted into the Department of Mathematics Education and succeeding to complete the B.Ed/BSc programme in mathematics education and graduating.

Table 3 shows that only six graduating years were considered since those admitted in 2009 academic year graduated in the 2013 academic year. From the table, it can be seen that not all students who were admitted into the mathematics education department were able to complete the B.Ed/BSc programme. In the 2013 academic year, out of the 14 admitted three could not make it to graduation making only 78.6 of them to graduate. This may be due to the fact that the student deferred the course on health grounds, failure to make the required GPA for progression to the next level, financial difficulties, etc.

In the 2011 academic year, however, even though eight (8) female students were admitted, as many as eleven (11) of them graduated from the department in 2015 academic year making as much as 137.5 of them to graduate (see column 4 in Table 4.3, for data on all graduating females). This can be explained by the fact that three more females with higher national diploma (HND) were admitted to join the cohort in the second year. This is possible because female (HND) holders are allowed to join the academic year group in their second year in the mathematics department.

Table 3 Proportion of students successfully completing the B.Ed/BSc programme in mathematics education (Department's retention)

	Qualified Females	Admitted Females	Females Graduating	
			All	Admitted Year 1
Graduating Year	N	N (%)	N (%)	N (%)
2013	14	14 (100)	11 (78.6)	11 (78.6)
2014	20	15 (75)	13 (86.7)	13 (86.7)
2015	8	8 (100)	11 (137.5)	8 (100)
2016	15	15 (100)	13 (86.7)	13 (86.7)
2017	26	25 (96)	25 (100)	25 (100)
2018	17	17 (100)	20 (117.6)	17 (100)
Average percent		96.5		92)

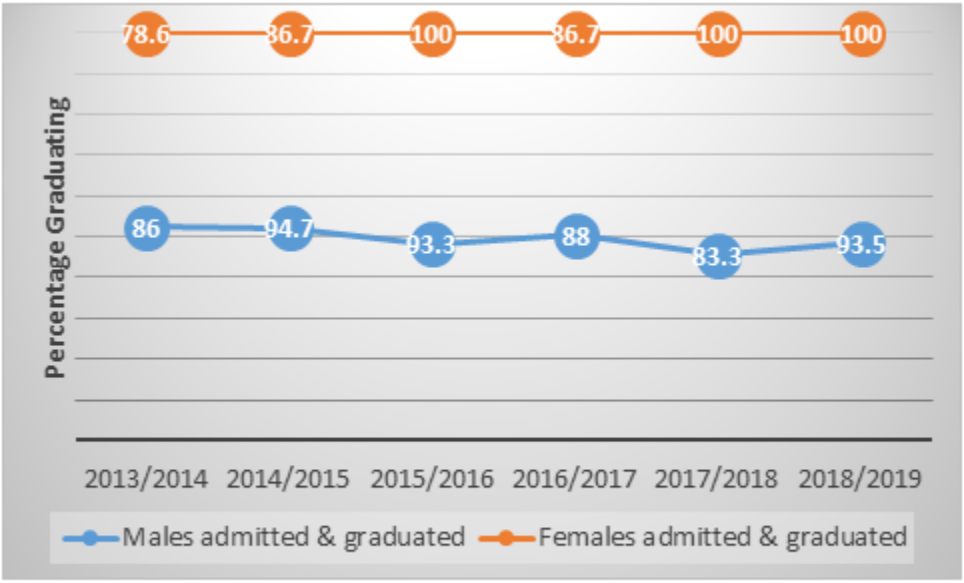

Figure 2 Proportion of female students successfully completing the Department of Mathematics (i.e.,retention rate of female students)

Figure 2 shows proportion of female students retained till graduation by the Department of Mathematics (i.e., retention of undergraduate female students). It can be seen clearly from Figure 2 that in three of the graduating years, 100% of the female students admitted in the first year graduated or were retained at the department (i.e., 100% retention rate). Therefore, when compared with females who were admitted in the first year, the proportion of students graduating or the trend in retention of undergraduate female students at the Mathematics Education Department has also been consistently high.

Discussion

This part of the chapter discusses the results based on the research questions. The result on question one which is on the trend in access of female undergraduate students who studied mathematics education in the decade from 2009 - 2018 revealed that female students are having access to study mathematics at the University of Education, Winneba. The trend in access for qualified undergraduate female students provided in the decade by the Mathematics Education Department in UEW had been consistently high (i.e., nearly all (or 96% - 100%) qualified applicants were admitted). But the proportion of female applicants ranged from 6.2% to 14.2% with a mean of 8.9% of the total applicants with is rather too low. This suggests that even though the Mathematics Education Department, and for that matter, UEW recognizes the need to secure equal access for females and males in science and mathematics education in the university, measures put in place, if any, in the decade achieved very little results. There is therefore the need for the Mathematics Education Department as well as the UEW to re-examine its admission policies in order to increase female applicants to science and mathematics education programmes to put it on the path of attaining the national policy ratio target of 60:40 in Science: Humanities respectively.

The results on research question one indicates that both male and female students have access to education in the Mathematics Education Department of UEW. However, the

analysis made shows that male students dominated in enrolment as compared to their female counterparts. This supports the finding in El-Yacoubi's (2015) study that indicated even though equity in education exists in most developed countries, gender equity in mathematics is relatively low. This is also in line with the findings of Odogwu, and Lawal's (2018) investigation into representation of female mathematics teachers, their interests and career progression in mathematics education in Nigeria. They observed at the senior secondary school level, females represent 35.2% of mathematics teachers. This also confirms the study conducted by Acheampong (2014) who investigated into disparity of gender participation of females in STEM related fields in higher education in Ghana. It was exposed that, even though Ghana had a population of about twenty-four million of which females form fifty-one percent of the entire population (Ghana Statistical Service, 2012), there is still minority of females participating in higher education in the fields of STEM.

According to UNESCO (2017) globally, access to girl's and women's STEM education is gradually improving especially in mathematics where most females decline to study. While access to education for girls and young women in STEM has globally improved important disparities persist both among and within regions and countries. Significantly access to education has made females to appreciate STEM programmes in recent decades. Also, Fletcher (2009), discovered that there is gender imbalance regarding participation in science, technology, and Mathematics education in Ghana. As a result, a number of intervention programmes aimed to achieving gender balance in participation in Science, Technology and Mathematics education in Ghana has been pursed for over twenty years. These researchers have led to the gradual increment of females in STEM courses.

The results on the trends in successful completion of female undergraduate students studying mathematics in the decade which is on research question two revealed that the few females who enrol for the mathematics education programme retain or stay on the course till the end of the four years programme. The finding is in line with the findings of a research conducted by STEM Women in 2021 where there was a linear increase in the number of women who remained on the programme and graduated in STEM related subjects **(**STEM Women, 2021). Even though the retention rate in UEW is high, it is not 100 per cent and it is important the department works to achieve the optimum. In this regard, the culture of academic department and other opportunities given to female students in colleges and universities are also identified as a critical issue for women's success in earning college degrees in mathematics (Seymour & Hewitt, 1997). Jane Margolis and Allan Fisher's research on women in computer science at Carnegie Mellon University and Barbara Whitten's work on women in college physics departments revealed that departmental culture is the key factor in female students' decision to remain in or leave these majors (Seymour & Hewitt, 1997). They stressed that departments should pay attention to the student experience to improve recruitment and retention of women and that having diverse faculty is also critical.

Conclusion

This study is concerned with the access, progression and learning achievement of females studying mathematics in higher education in Ghana. Its aim is to describe the access, successful completion and learning achievements of female undergraduate students studying mathematics in the

University of Education, Winneba (UEW) from 2009 to 2018. It explored the gender distribution of undergraduate students who studied mathematics in UEW in the decade and investigated the trends in access, retention and successful completion of female undergraduate students who studied mathematics in the decade. It also investigated the trends in the learning achievement of the female undergraduate students who graduated in the decade.

The study was based on secondary data extracted from the university's admission and graduation records. The study therefore employed the methodology of secondary data analysis (SDA) which has received wide recognition in the global scientific community. Besides saving time and money for data collection when compared to other means, the secondary data analysis (SDA) research was adopted to replace the original questionnaire survey research on "Females participation and achievement in mathematics in Ghanaian Teaching Universities" which was abandoned as a result of the COVID-19 lockdown. In this study, SDA methodology was used in isolation (i.e., without combining with primary data) for the purpose of assessing the data set with respect to the research questions that are related to access, successful completion, and learning achievement of female undergraduate students who studied mathematics at University of Education, Winneba from 2009 to 2018. A template was developed to capture the data from the UEW Planning Unit and others were obtained online from statistical publications to authenticate the Planning Unit data.

Recommendations

Based on the findings on the study the following recommendations are made:

1. The Mathematics Department of the University, in collaboration with other stakeholders (NGOs), should through sensitization encourage females in basic and senior high schools to do mathematics and mathematics education courses by spelling out various career opportunities to them.
2. Headmasters or mistresses of senior high schools should support the organisation of Math Clubs to motivate female students to further mathematics at the tertiary level.
3. Female mathematics students in UEW who are very good should be given a lot of support to increase their chances of getting a First-class; and those who are average or below average in performance should be given more support in order to reduce the proportion of female students getting a Third class.
4. A future study should include more tertiary institutions to improve the sample size and generalizability of the results of the study.

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