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Emergence of More Female Role Models in the Sciences: The Case of Students' Academic Performance in a Nigerian Private University

Dorcas Modupe Okewole
Senior Lecturer, Department of Mathematical Sciences,
Redeemer's University, Ede, Osun State, Nigeria
Bosede Oyenike Oguntunde
Senior Lecturer, Department of Computer Science,
Redeemer's University, Ede, Osun State, Nigeria
Theresa Omolayo Ojewumi
Assistant Lecturer, Department of Computer Science,
Redeemer's University, Ede, Osun State, Nigeria

Abstract:
In this article, we present an empirical study to provide more evidence on the strength of the female gender in the sciences. It is on record that the percentage of women in the sciences is still low compared to the male counterpart. This paper is thus intended to make use of the performance of female undergraduates in the sciences to encourage more participation from this group. The study focused on six science courses that already graduated students from Redeemer's university for at least 4 years as at the time of the research. We compared the average performance of female students with that of male students in each program over 5 years. The results obtained suggest that female students also have great potentials in the sciences, with better performance in some instances than male students. Consequently, we encourage more women participation in Science, Technology, Engineering and Mathematics (STEM) disciplines.

Keywords: *Gender, outstanding performance, Cumulative Grade Point Average (CGPA), mother's education, female role models, female-child education*

1. Introduction

The importance of studies on students' academic performance cannot be overemphasized. Various authors present their views, models and results of empirical research in this regard, for example, Choy J. L. Fung and Quek C. L. (2016), Cortes et. al. (2014), Lunsford et. al. (2018), Palmer S. (2013), Migueiset. al. (2018), and Van Es C. & Weaver (2018). The central goal is to have a sustainable improvement in students' academic performance and the quality of education generally. However, we can only achieve sustainable improvements in quality of education when all stake-holders are adequately carried along, but not when a particular group is grossly under-represented, which has been the case of female participation in the sciences. Meanwhile, the role of mother's education on children's academic performance has been emphasized in literature, for example Okewole (2012). It is a known fact that the percentage of women in the Science, Technology, Engineering and Mathematics (STEM) disciplines is still substantially low compared to the male counterpart (Howe-Wash and Turnbull, 2014). Blackburn (2017) gave a review of literature on the status of women in STEM in higher education. The study presented issues that concerns areas of classroom experiences, campus culture, identity, sense of belonging, recruitment, retention, among others. Although Blackburn reported that women are motivated now more than ever to choose STEM fields as careers, it was stated that reports of students' experiences revealed more barriers still hindering successful degree completion and career entry.

In a much earlier study (Woolnough et al., 1997), factors affecting student choice of career in science and engineering were presented from parallel studies of six countries. An important message from the study was that there was not a single factor which influenced all students the same way; rather, different students were influenced most by completely different factors. Consequently, we base this study on the idea that there is the possibility of some students being influenced by the outstanding good performance of students who are already pursuing a career in the STEM disciplines. Furthermore, the studies of Van Raden (2011) and Herrmann et al (2016) among others indicated a positive impact of role modeling on career choices while Prunuske*et al*. (2016) presented a result in which mentoring also positively influenced participation in sciences. Moreover, Owen (2018) reported the outcomes of a survey with the conclusion that there was a need to 'expose more girls and young women to positive female role models and mentors who have been successful in their field' (p. 1). The study that we present here is therefore targeted at indicating the availability of such potential female role models who are already being successful in their fields at the undergraduate level.

The rest of the paper is arranged as follows: the research methods and materials are described in section 2.0, results in section 3.0 and conclusions are made in the last section (4.0).

2. Methodology

The Cumulative Grade Point Average (CGPA) of students at the end of second semester of 400 level (final year) were used for the study as a measure of their performance. The results were grouped into male and female across the programs included in the study.The programs are Biochemistry (BCH), Computer science (CMP), Industrial Chemistry (ICH), Industrial Mathematics (IMA), Microbiology (MCB), and Physics with Electronics (PHY). We collected the results of 5 consecutive sessions – 2014/15, 2015/16, 2016/17, 2017/18, and 2018/19. The results were available for the all the programs listed except for industrial mathematics in 2018/19. First, we provided a summary of the distribution of number of students across the various CGPA categories by gender, using charts. We then compared the CGPA of female students with that of male students using independent sample T-test. Enrolments for industrial mathematics were very low across the years included in the study. Consequently, comparison of performance by gender for the course was done only descriptively, except for 2014/15 in which case a test of independence was done.

3. Results

The distribution of the results for both male and female over the 5 years considered are presented with charts in figures 1 to 6.

In the computer Science programme, there were more female students than male in the higher CGPA 2.5 to 3.49, 3.5 to 4.49 and 4.5 to 5.0 than the lower ones (fig. 1). This implies that the female students though fewer in number than the male counterparts, were outstanding in their academic performance.

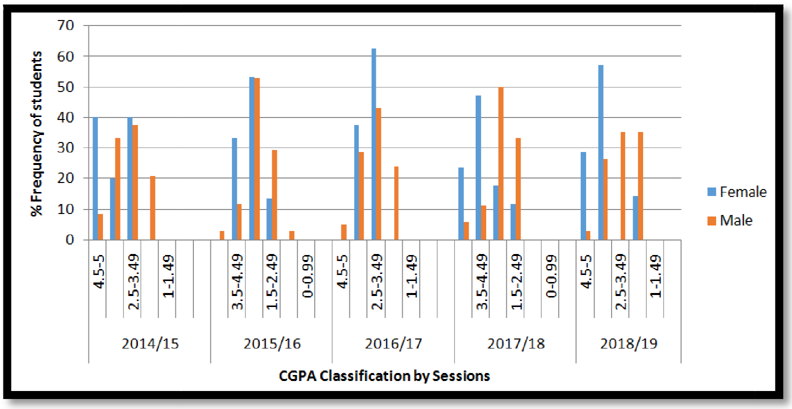

Figure 1: Percentage of Computer Science Students for Various CGPA Classifications

The results of microbiology students (fig 2) also reflect that female students are found in the higher CGPAs than the male students for 2016/17 (2.5 to 3.49 and 4.5 to 5.0) and 2017/18 (3.5 to 4.49 and 4.5 to 5.0), while in all the sessions, there are more male students in the lower CGPAs (< 2.5) than female. The implication of this is that female students are not doing badly at all.

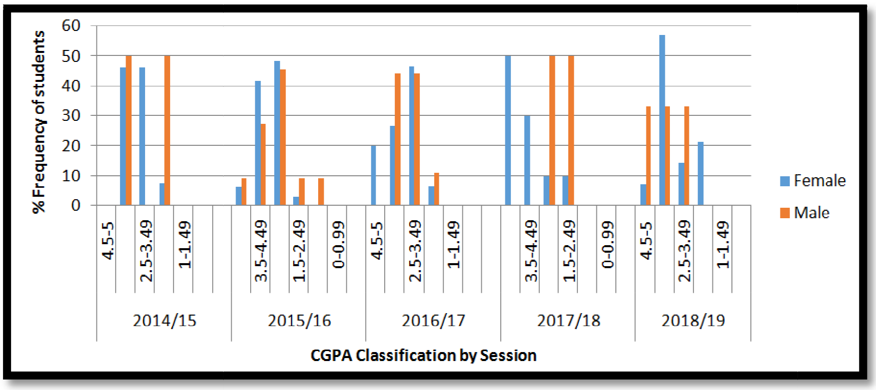

Figure 2: Percentage of Microbiology Students for Various CGPA Classification

Results from Biochemistry programme (fig 3)were also similar to those for computer science and microbiology. For all the sessions except 2015/16, there were more female students than male in the highest CGPA 4.5 – 5.0

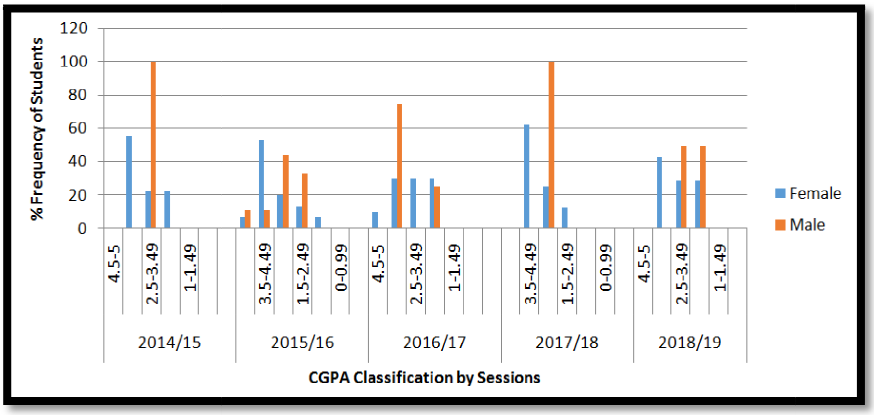

Figure 3: Percentage of Biochemistry Students for Various CGPA Classification

The performance of both male and female students in Industrial Chemistry (fig. 4) can be seen as similar. In 2017/18, there were more male than female students in the higher CGPAs (≥ 2.5) while in 2015/16 and 2016/17 there were more female than male students.

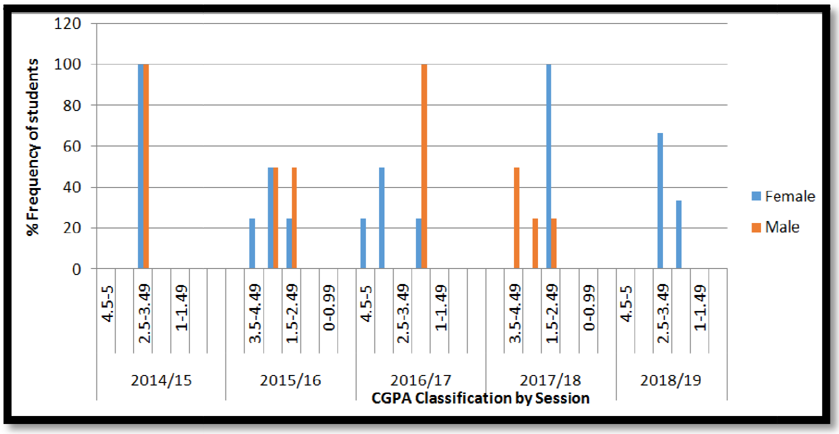

Figure 4: Percentage of Industrial Chemistry Students for Various CGPA Classification

The results shown in fig. 5 and 6 suggests that there are not many differences in the performance of both male and female students in Physics with Electronics and Industrial Mathematics

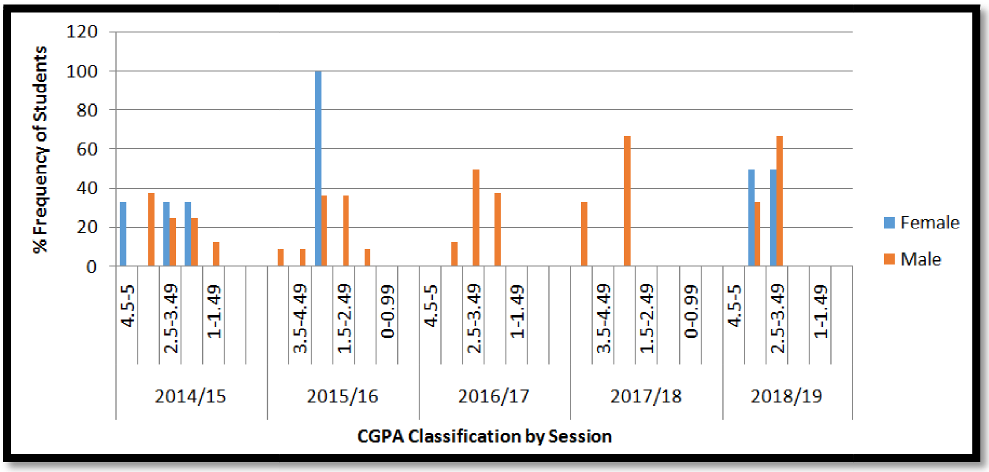

Figure 5: Percentage of Physics with Electronics Students for Various CGPA Classification

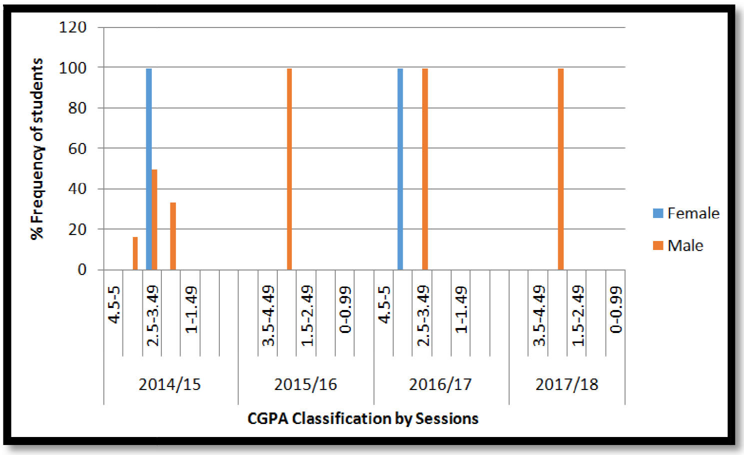

Figure 6: Percentage of Industrial Mathematics Students for Various CGPA Classification

Comparison of the results by gender (independent t-test) gave the results in table 1

Course	Year									
	2014/15		2015/16		2016/17		2017/18		2018/19	
	$\bar{F}-\bar{M}$	P-VALUE	$\bar{F}-\bar{M}$	P-VALUE	$\bar{F}-\bar{M}$	P-VALUE	$\bar{F}-\bar{M}$	P-VALUE	$\bar{F}-\bar{M}$	P-VALUE
BCH	0.5589	0.078	0.434	0.295	-0.2495	0.69	0.223	0.767	0.451	0.571
CMP	0.7813	0.055	0.4711	0.048	0.156	0.568	0.824	0.001	0.79	0.029
ICH	B	B	-0.8175	0.306	1.931	0.329	0.53	0.503	-0.02	A
IMA	-0.4017	0.684	A	A	A	A	C	C	D	D
MCB	0.52	0.384	0.4482	0.081	0.241	0.476	1.302	0.011	-0.499	0.388
PHY	0.217	0.774	0.685	0.345	C	C	C	C	0.22	0.845

Table 1: Male-Female Comparison of Undergraduate Students' Final CGPA

NOTE
A -Only 1 student each available for both male and female
B - Only females took the course
C -Only males took the course
D - No student took the course

First, there's a need to take note of the distribution of the students by gender as background information for the performance comparison. The percentage of female students in the microbiology program was higher than that of male students for all the years included in the study. For instance, in 2018/19 it was 82.4% female and 17.6% male. There were also more female than male students in biochemistry as well as industrial chemistry programs. On the other hand, the percentage of male students was higher than that of female students in computer science program for all the years, with 82.9% male and 17.1% female in 2018/19. Physics with electronics and industrial mathematics programs also had more male than female students. In physics with electronics, there were two sessions having only male students. These statistics implies that distribution of students by gender in the sciences varies across the programs. Despite this fact, the performance of female students in all the programs over the five years was either not significantly different from that of male students in some cases or significantly greater than that of the male students in other cases. At the 5% level of significance, the least probability value among the cases with no significant gender difference in CGPA was P = 0.055. Female microbiology students performed better than their male counterparts in 2017/18 (P = 0.011) while female computer science students had a higher performance in 2015/16 (P = 0.048), 2017/18 (P = 0.001) and 2018/19 (P = 0.029).

4. Discussion

The distribution of the results by gender across CGPA groups in all the science programs considered implies that female students compete adequately with their male counterparts in academic performance. The result is the same irrespective of the proportion of female students in a class, whether there are more females than male or vice versa. Johnson and Kposowa (2018) identified marital status and religion as major factors influencing gender disparity in educational status in Ghana implying that gender disparity will not be significant where religion and marital status are constant, a result that may be similar in some other developing nations. This could be taken as possible explanation for female students competing adequately with their male counterparts in our present study where religion and marital status are constant (the students are mostly unmarried and in the same religious sect). Feminist peer mentoring was identified by Macoun and Miller (2013) as contributing positively to personal validation and providing intellectual resources in understanding their position in the university. It is therefore expected that the availability of academically sound female students in the sciences as indicated in this study can lead to improvements in female participation. Although this study did not link mentoring with female students' academic performance, it all the same laid emphasis on availability of females that can adequately fit the role of academic mentors for sustainability of the female gender in the sciences.

5. Conclusion

A major conclusion drawn from this study is that academic performance of female students in the sciences is generally outstanding. The outstanding performance is regardless of the proportion of female students in the class. This article has therefore emphasized the emergence of more outstanding females in STEM disciplines who could consequently serve as role models for other aspiring females. In other words, female students with science affinity at the high school level as well as their parents/guardians are encouraged to answer the question 'since other females are doing well in thesefields, why can't I?'Moreover, the evidence from this study suggests the need for paradigm shift of attitude in some developing countries where there has been serious bias against female child education. Further research on this may be to highlight the relationship between female participation in STEM disciplines and career practice after graduation.

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Appendix

The distribution of CGPA by Gender are presented in tables 2 to 7. The values in parenthesis are the percentages

CGPA Classes	2014/15		2015/16		2016/17		2017/18		2018/19	
	F	M	F	M	F	M	F	M	F	M
4.5-5	2(40)	2(8.3)	0	1(2.9)	0	2(4.8)	4(23.5)	2(5.6)	2(28.6)	1(2.9)
3.5-4.49	1(20)	8(33.3)	5(33.3)	4(11.8)	3(37.5)	12(28.6)	8(47.1)	4(11.1)	4(57.1)	9(26.5)
2.5-3.49	2(40)	9(37.5)	8(53.3)	18(52.9)	5(62.5)	18(42.9)	3(17.6)	18(50)	0	12(35.3)
1.5-2.49	0	5(20.8)	2(13.3)	10(29.4)	0	10(23.8)	2(11.8)	12(33.3)	1(14.3)	12(35.3)
1-1.49	0	0	0	1(2.9)	0	0	0	0	0	0
0-0.99	0	0	0	0	0	0	0	0	0	0

Table 2: Distribution of CGPA by Gender for Computer Science

CGPA Classes	2014/15		2015/16		2016/17		2017/18		2018/19	
	F	M	F	M	F	M	F	M	F	M
4.5-5	0	0	2(6.5)	1(9.1)	3(20)	0	5(50)	0	1(7.2)	1(33.3)
3.5-4.49	6(46.15)	3(50)	13(41.9)	3(27.3)	4(26.7)	4(44.4)	3(30)	0	8(57.1)	1(33.3)
2.5-3.49	6(46.15)	0	15(48.4)	5(45.5)	7(46.6)	4(44.4)	1(10)	2(50)	2(14.3)	1(33.3)
1.5-2.49	1(7.7)	3(50)	1(3.2)	1(9.1)	1(6.7)	1(11.1)	1(10)	2(50)	3(21.4)	0
1-1.49	0	0	0	1(9.1)	0	0	0	0	0	0
0-0.99	0	0	0	0	0	0	0	0	0	0

Table 3: Distribution of CGPA by Gender for Microbiology students

	2014/15		2015/16		2016/17		2017/18		2018/19	
	F	M	F	M	F	M	F	M	F	M
4.5-5	0	0	1(6.7)	1(11.1)	1(10	0	0	0	0	0
3.5-4.49	5(55.6)	0	8(53.3)	1(11.1)	3(30)	3(75)	5(62.5)	0	3(42.8)	0
2.5-3.49	2(22.2)	3(100)	3(20)	4(44.4)	3(30)	0	2(25)	1(100)	2(28.6)	1(50)
1.5-2.49	2(22.2)	0	2(13.3)	3(33.3)	3(30)	1(25)	1(12.5)	0	2(28.6)	1(50)
1-1.49	0	0	1(6.7)	0	0	0	0	0	0	0
0-0.99	0	0	0	0	0	0	0	0	0	0

Table 4: Distribution of CGPA by Gender for Biochemistry Students

	2014/15		2015/16		2016/17		2017/18		2018/19	
	F	M	F	M	F	M	F	M	F	M
4.5-5	0	0	0	0	1(25)	0	0	0	0	0
3.5-4.49	0	0	1(25)	0	2(50)	0	0	2(50)	0	0
2.5-3.49	1(100)	1(100)	2(50)	1(50)	0	0	0	1(25)	2(66.7)	0
1.5-2.49	0	0	1(25)	1(50)	1(25)	2(100)	2(100)	1(25)	1(33.3)	0
1-1.49	0	0	0	0	0	0	0	0	0	0
0-0.99	0	0	0	0	0	0	0	0	0	0

Table 5: Distribution of CGPA by Gender for Industrial Chemistry Students

	2014/15		2015/16		2016/17		2017/18		2018/19	
	F	M	F	M	F	M	F	M	F	M
4.5-5	1(33.3)	0	0	1(9.09)	0	0	0	1(33.3)	0	0
3.5-4.49	0	3(37.5)	0	1(9.09)	0	1(12.5)	0	0	1(50)	1(33.3)
2.5-3.49	1(33.3)	2(25)	1(100)	4(36.4)	0	4(50)	0	2(66.7)	1(50)	2(66.7)
1.5-2.49	1(33.3)	2(25)	0	4(36.4)	0	3(37.5)	0	0	0	0
1-1.49	0	1(12.5)	0	1(9.09)	0	0	0	0	0	0
0-0.99	0	0	0	0	0	0	0	0	0	0

Table 6: Distribution of CGPA by Gender for Physics with Electronics Students

	2014/15		2015/16		2016/17		2017/18	
	F	**M**	**F**	**M**	**F**	**M**	**F**	**M**
4.5-5	0	0	0	0	0	0	0	0
3.5-4.49	0	1(16.7)	0	0	1(100)	0	0	0
2.5-3.49	1(100)	3(50)	0	1(100)	0	1(100)	0	2(100)
1.5-2.49	0	2(33.3)	0	0	0	0	0	0
1-1.49	0	0	0	0	0	0	0	0
0-0.99	0	0	0	0	0	0	0	0

Table 7: Distribution of CGPA by Gender for Industrial Mathematics Students