

STEM Education in the Republic of Mauritius; a Gender Perspective

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Abstract

Promoting women's participation in Science, Technology, Engineering and Mathematics (STEM) can only be beneficial considering that women are more than 50% of the Mauritian population. This study aimed at analysing the relationship between gender and STEM education in Mauritius over the last six years. Gender gaps in STEM enrolment and in professional aspirations of students were assessed both at secondary and tertiary levels. Factors influencing girls to pursue higher studies were identified. The methodology used consisted of surveys and interviews for quantitative and qualitative assessments respectively. Female enrolment exceeded 50% at both secondary and tertiary level during the study period. However, a strong gendered pattern appeared in the STEM student population in both secondary and tertiary levels. The subject distribution for girls at O and A levels were very low in hard core sciences such as Physics, Computer Studies and Design and Technology. At tertiary level, the field distribution for girls was low for Engineering and Information Technology. A thorough evaluation of gender gaps at doctoral level was also undertaken. The percentage of male enrolment at doctoral level has been higher than female enrolment. The gender gap is more striking in STEM fields of study. Out of 16% of doctoral students opt for STEM, only 5% are accounted for by female students. The importance of family support was also highlighted in the professional career of women interviewed. It is recommended that the gender gap in STEM be addressed using a holistic approach with the following partners: Government, Industry, Society, Family and Teachers.

Keywords: STEM, Secondary and Tertiary Education, gender, female participation

1. INTRODUCTION

The Republic of Mauritius is a Small Island Developing State, with its main resources being its human and ocean resources. The local population is estimated to 1.3 million inhabitants, 50.5% of which consists of women (Statistics Mauritius, 2019). The Government of Mauritius is striving to become a knowledge-based economy and education is a crucial factor in this path; education for all, leaving no one behind is essential.

From a gender wise perspective, girls perform better than boys at the Primary School Achievement Certificate (PSAC) examinations. In 2019, the pass rate for girls was nearly 82% against 72% for boys (Mauritius Examination Syndicate, 2020). The proportion of pupils stepping from primary level to secondary level in 2015 was around 94% for boys and 97% for girls. The Gender Parity Index (GPI) in secondary enrolment, which measures the relative access to secondary education of males and females was 1.1 in 2018 showing a disparity in favour of girls (Statistics Mauritius, 2019). Compared to boys, girls are less likely to drop out from secondary academic stream. Tertiary enrolment for both girls and boys increased over time but with a widening gap in favour of girls. Tertiary enrolment, as measured by the Gross Tertiary Enrolment Rate (GTER), rose from 16.0% in 2000 to 54.3% in 2017 for women, and from 14.1% to 38.9% for men during the same period (Statistics Mauritius, 2018).

The empowerment of women is recognised in the Sustainable Development Goals (SDGs) adopted by the United Nations (UN) General Assembly in September 2015. SDG 5 is to 'Achieve gender equality and empower all women and girls'. Access to education is essential for the female gender to be empowered and able to participate in the economy of the country. Women, being over half of the local population, cannot be ignored in the local context. National statistics indicate that there is no gender variation in access to education. In the same context, it is noteworthy that innovation as well as knowledge in science and technology are important in economic growth (Saperstein and Rouach, 2002); understanding and participation in science are also perceived as being closely linked to power (Bleier, 1988). This close linkage between science and economic growth are hence, critical factors when it comes to empowerment of the female gender. And yet women are under-represented in Science, Technology, Engineering and Mathematics (STEM) majors and careers in many countries around the world (Blickenstaff, 2005). Many studies have reported on such under-representations and there are various reasons that led to this situation (Huyer, 2004, Abreu, 2012, ASSAF, 2011, Ephraim, 2011, UNESCO Institute for Statistics, 2003, UNESCO 2007, UNESCO 2010). This was attributed to the reluctance of girls to pursue studies in STEM, tendency of employers to prefer appointing male workers in these fields, not enough women on selecting panels, working conditions not being favourable to women given their additional roles requiring some flexibility as mothers and in the household. These factors suggest that access to STEM education need special attention when it comes to women empowerment.

This study is an attempt to get a first comprehensive picture of the representation of women in STEM Education in the Republic of Mauritius. Participation in STEM Education is the first step in a STEM career. The relationship between gender and STEM education at secondary and tertiary education levels is analysed. Relevant potential strategies will be proposed on evidence, that is, real data coupled with qualitative information obtained from discussions with the concerned stakeholders.

The objectives of the study are:

- i. to assess the pattern of girl's enrolment compared to boy's enrolment for STEM subjects at both secondary and tertiary levels;
- ii. to assess gender differences in STEM enrolment at doctoral level;
- iii. to conduct a preliminary analysis of:
 - a. the impact of gender on professional aspirations of doctoral students,
 - b. the motivational factors influencing girls to pursue doctoral studies in STEM fields.
- iv. to identify potential strategies to increase the participation of women in STEM education from the gathered data.

2. METHODOLOGY

2.1 Scope of study

The study covers secondary and tertiary enrolment in publicly funded secondary and tertiary institutions. It consisted of both qualitative and quantitative analysis to evaluate participation of girls/women in STEM Education and to assess the factors influencing their participation.

2.2 Enrolment rate at secondary and tertiary education

Male and female enrolment rates in STEM and non-STEM fields were analysed from academic years 2013 to 2018, both at secondary and tertiary levels. The impact of gender on choice of different STEM subjects/ fields was also analysed. At secondary education level, the distribution of students opting for STEM subjects at O-Level and A-Level were analysed. These two levels were chosen because there are times when students are requested to opt for specific fields, these occur at the fourth and sixth years of their secondary education.

2.3 Qualitative Analysis

Survey and Interviews

In order to understand specific factors, which might influence gender variation in enrolment for doctoral degrees; two qualitative exercises were undertaken for the doctoral population.

The first exercise covered both male and female doctoral students in a randomly selected group of 100 students. The following information was collected from surveyed students: age, gender, field of study, number of publications, gender of supervisor, interest for post-doctoral studies and professional /career aspirations. This exercise included both STEM and non-STEM students.

The second exercise was individual interviews with seven women pursuing doctoral studies in STEM fields. The discussions probed in the influential factors impacting on their decision to pursue their doctoral study, their role model, their experience of gender bias in their career. They were asked more personal details regarding the impact of their studies on their personal lives as spouses/girlfriends and their intention to start a family.

3. FINDINGS

3.1 Student population in publicly funded secondary institutions

The average total number of students participating in O-level examinations from 2013 to 2018 was 15 563 while for A-level, it was 9864. The percentage of girls out of the total student population during that time period exceeded 50% (Figure 1).

Table 1. Student participating in O-level examinations for the year 2013 to 2018 for O-level and A-level

Year	Total number of students at O Level	Total number of students at A Level
2013	15 890	10 287
2014	15 632	10 429
2015	15 675	10 285
2016	15 455	9 285
2017	15 352	9 490
2018	15 374	9 408

(Mauritius Examinations Syndicate, 2013-2018)

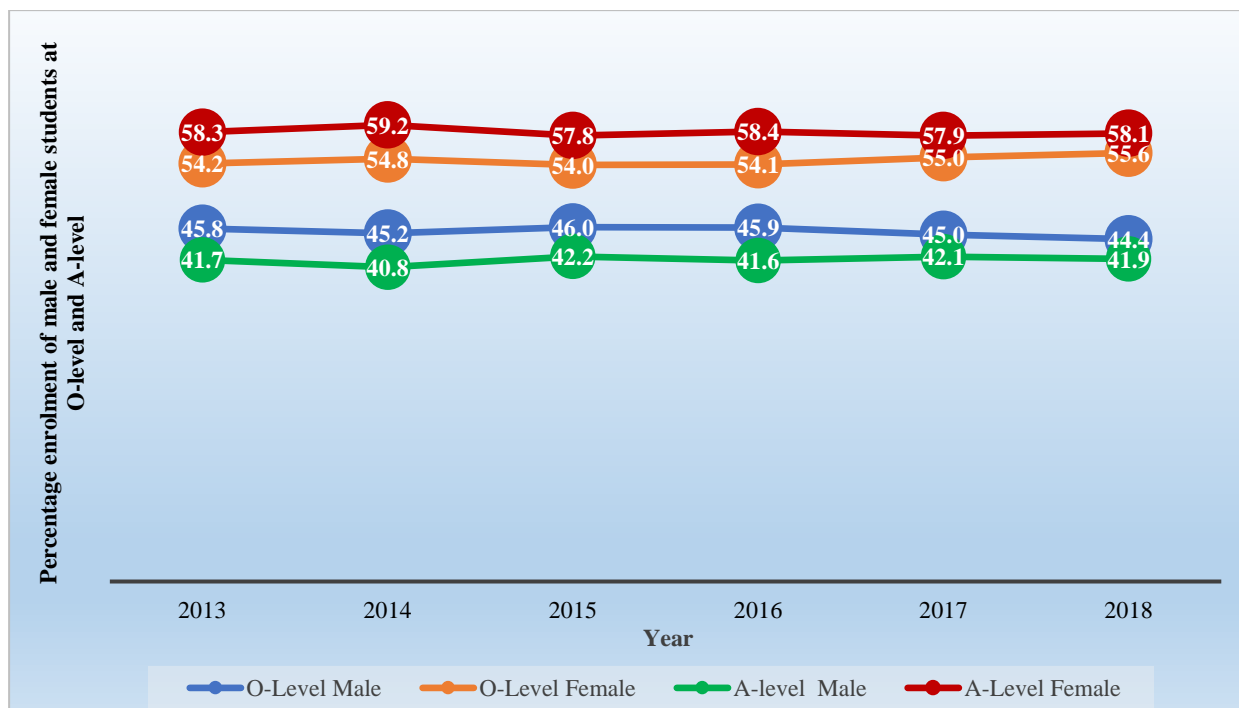


Figure 1. Student profile at O level and A-level (Mauritius Examination Syndicate, 2013-2018)

3.2 Evaluating the pattern of STEM Enrolment at secondary level

The percentage of students opting for STEM subjects at O-level varied from 35% to 40% over the studied years while it has varied from 31% to 34% at A-level for the same time span.

For both O and A levels, it is clear that the proportion of male students opting for STEM is higher than the proportion of female students (Table 2).

Table 2. Enrolment rates (%) for STEM subjects at O-level and A-level

Year	O-Level (%)			A-level (%)		
	Male	Female	Total	Male	Female	Total
2013	20	15	35	18	14	32
2014	21	17	38	18	14	32
2015	21	15	36	20	14	34
2016	23	16	39	18	13	31
2017	23	17	40	n/a	n/a	n/a
2018	23	16	39	n/a	n/a	n/a

(Mauritius Examinations Syndicate, 2013-2018)

3.3 Assessing preference for different STEM subjects

Enrolment of students for different STEM subjects is shown in Figure 2 and Figure 3.

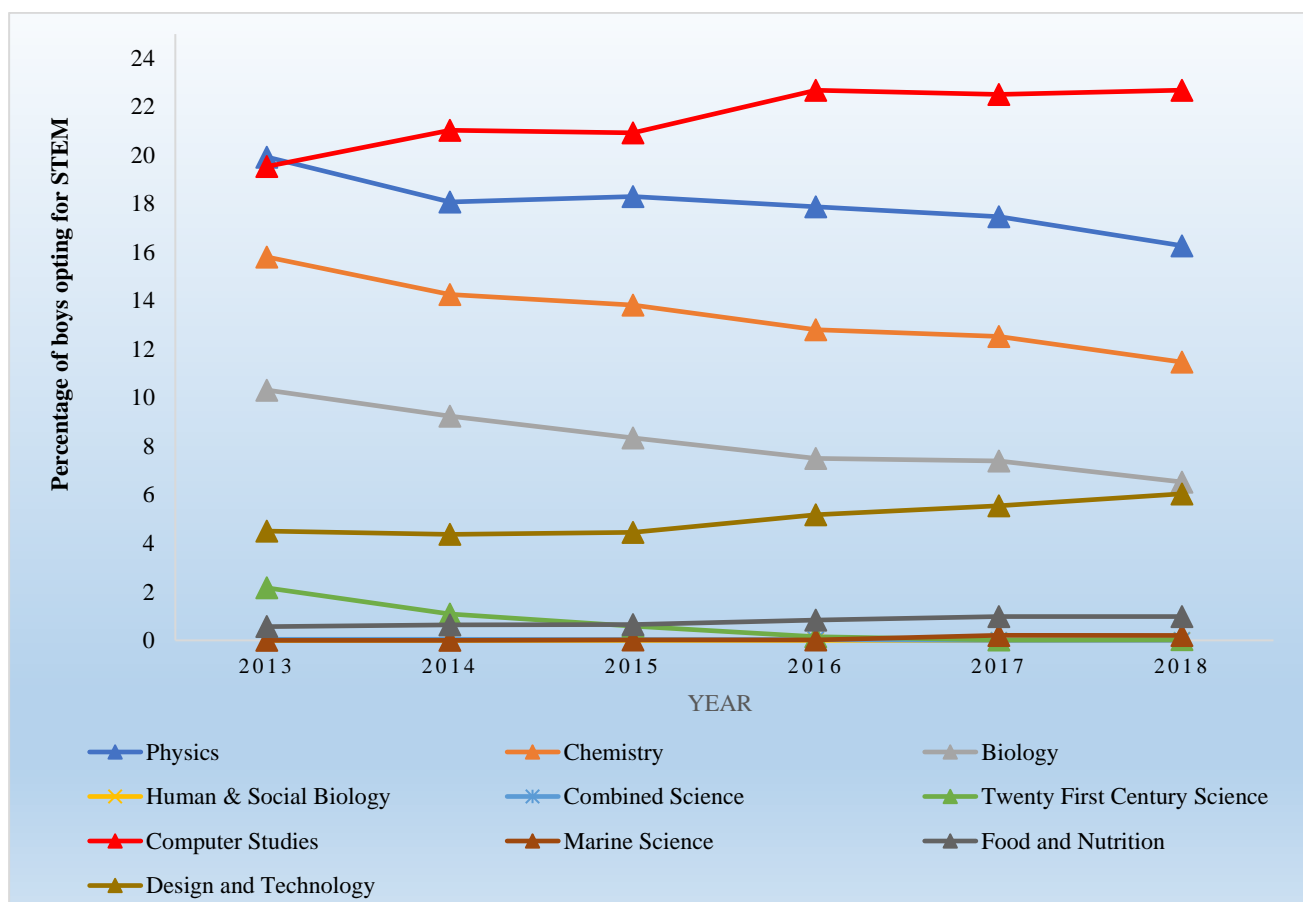


Figure 2. Male enrolment rate for STEM subjects at O-Level (Mauritius Examinations Syndicate, 2013-2018)

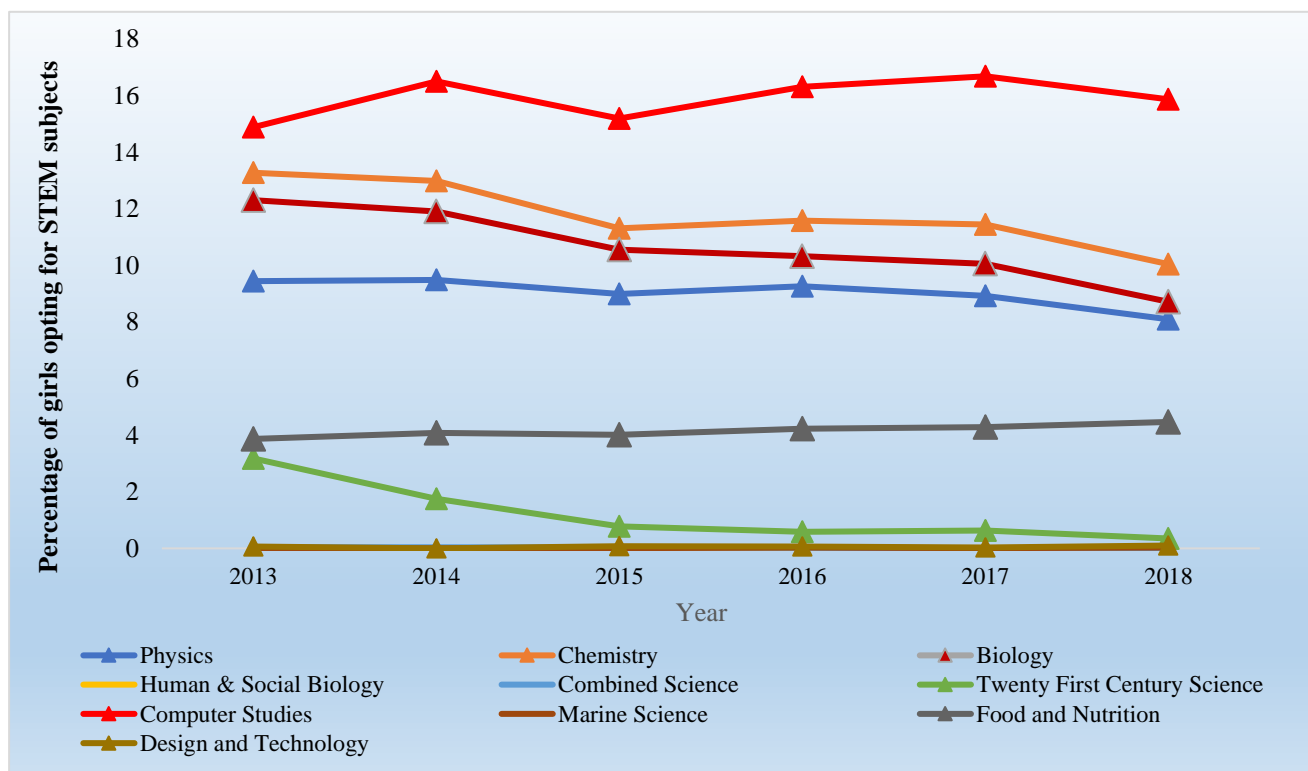


Figure 3. Female enrolment rate for STEM subjects at O-Level (Mauritius Examinations Syndicate, 2013-2018)

The most popular STEM subjects were Computer Studies, Chemistry, Biology followed by Physics. The two most popular subjects were found to be Computer studies (34-39%) and Physics (24-29%); Computer studies have gained importance over the years, with the percentage of students opting for this subject increasing from 34% in 2013 to 39% in 2018. On a gender wise basis, it can be noted that the percentage of male students opting for Computer Studies and Physics (20-23% and 16-20% respectively) is higher than the percentage of female students (15-17% for Computer Studies and 8-9% for Physics). Physics is the least popular subject for girls compared to boys.

At A-level, Physics and Chemistry were the most popular subjects, irrespective of gender. The female enrolment rate for Biology is higher than that of male enrolment rate.

However, 8.3% to 9.7% of male students out of the total student population choose Design and Technology as a subject while female participation for this subject is negligible (less than 0.5%).

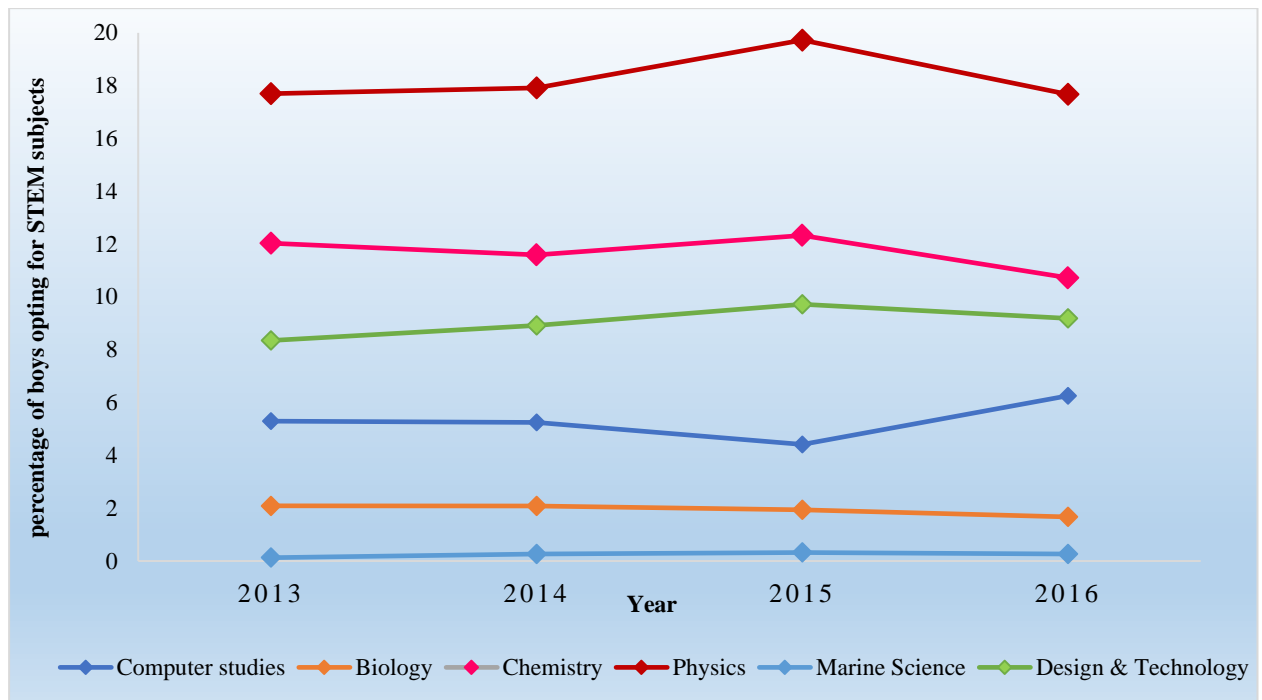


Figure 4. Male enrolment ratio for STEM subjects at A-level (Mauritius Examinations Syndicate, 2013-2016)

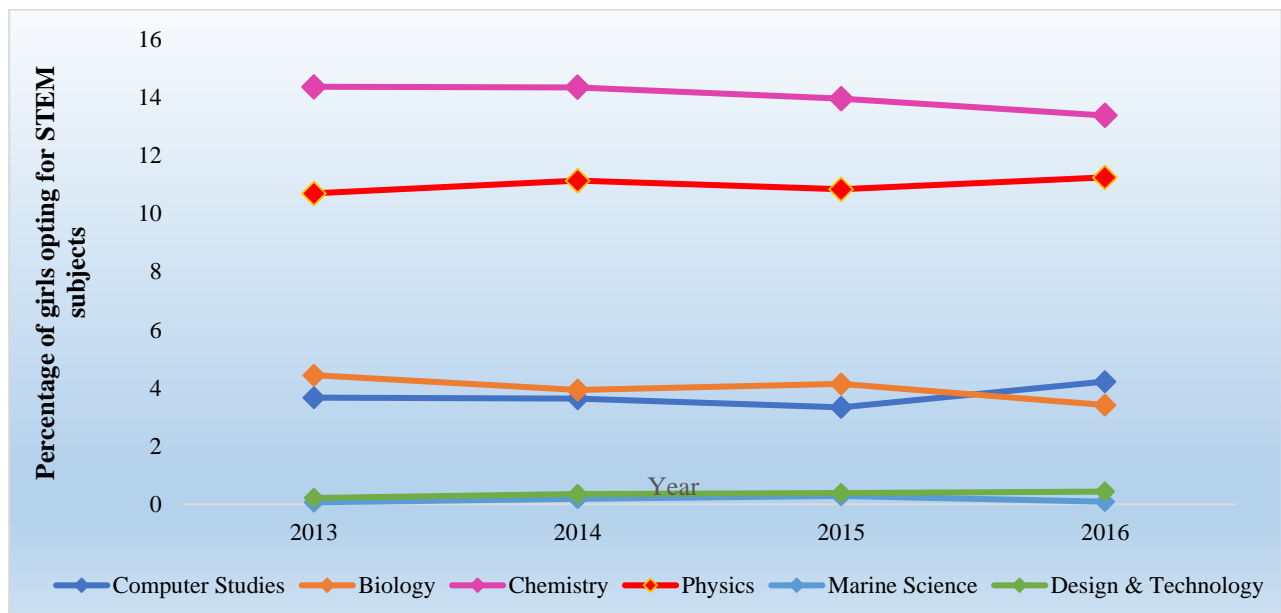


Figure 5. Female enrolment ratio for STEM subjects at A-level (Mauritius Examinations Syndicate, 2013-2016)

3.4 Tertiary education

The number of students attending PFI's from academic years 2012/2013 to 2017/2018 ranged from 20 534 to 23 246 (Table 3). The total percentage of female students (56-60%) was higher than that of male students over the six academic years. However, when STEM subjects are analysed, the population of male students opting for STEM (17.4% to 19.4%) was higher than that of female students (11.1-12.9%) (Figure 6).

Table 3. Student population for Publicly-Funded Tertiary Education Institution by year and gender

Year	Total number of students attending PFIs	Male	Female
2012/2013	21 348	8552	12 796
2013/2014	23 246	10 111	13 135
2014/2015	22 330	9671	12 625
2015/2016	21 233	8825	12 408
2016/2017	20 534	8482	12 052
2017/2018	21 331	8486	12 895

(Tertiary Education Commission, 2012/2013-2017/2018)

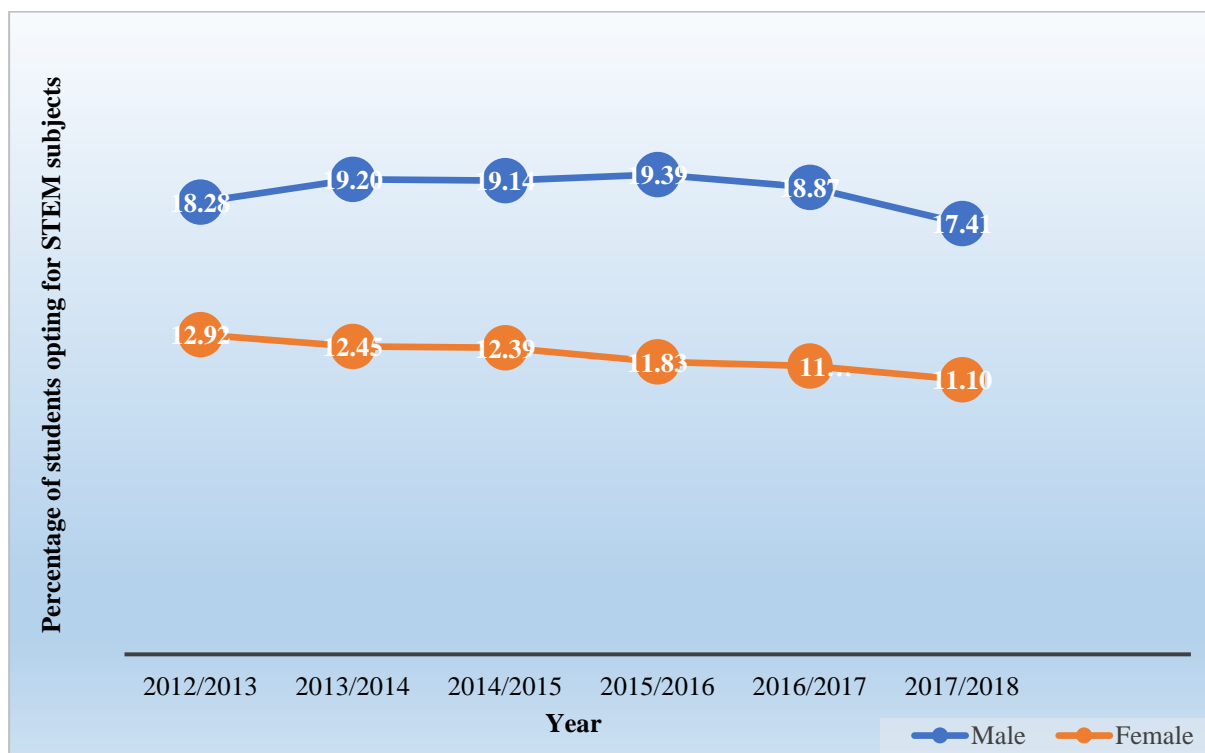


Figure 6. Percentage of students opting for STEM subjects at tertiary level (Tertiary Education Commission, 2012/2013-2017/2018)

The mean percentage of male and female students opting for different STEM fields is shown in Figure 7.

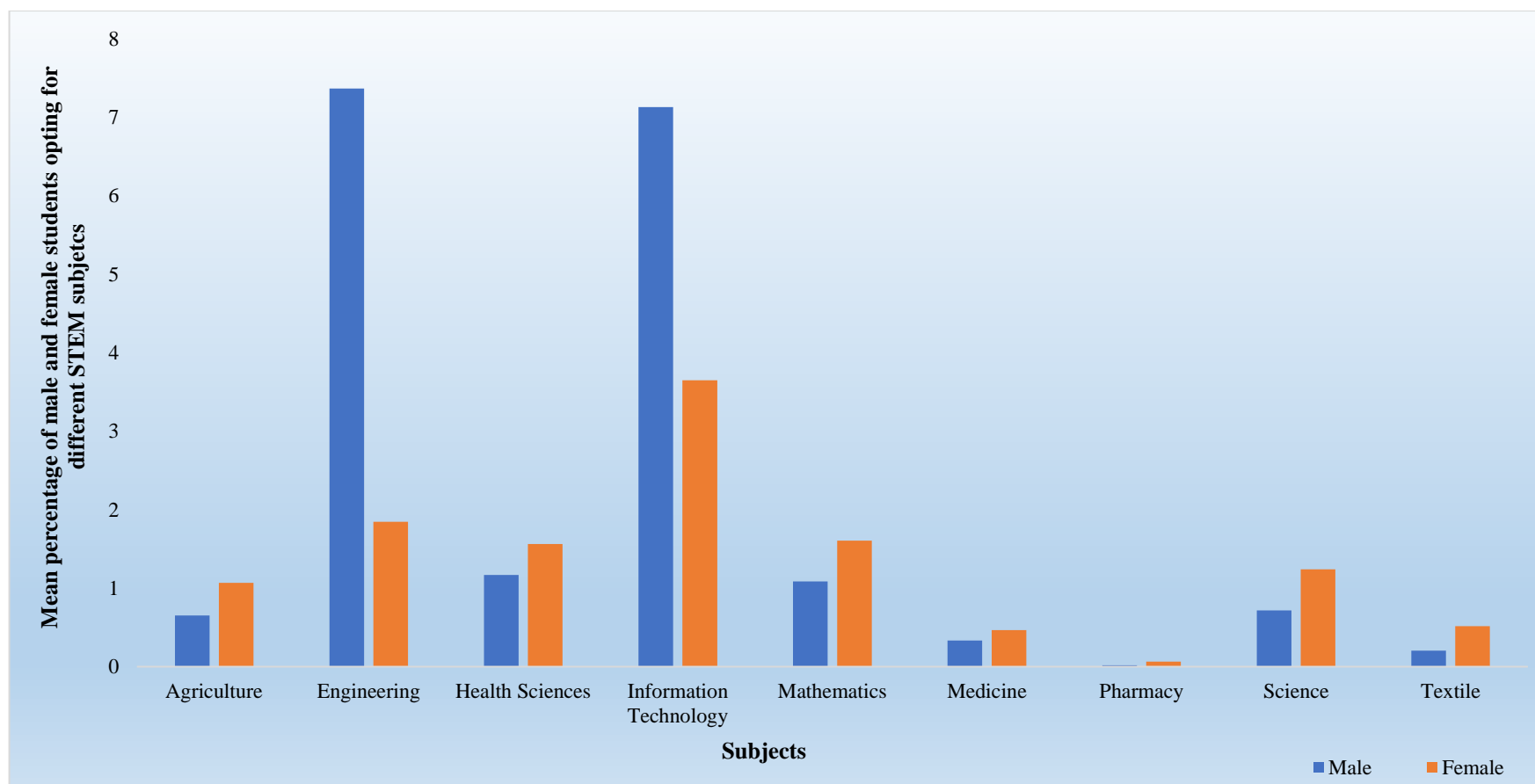


Figure 7. Mean percentage of male and female students opting for different STEM subjects (Tertiary Education Commission, 2012/2013-2017/2018)

The two most popular subjects were Information Technology, with average total participation of 10.8% and Engineering (9.2%), incidentally these were also the only two fields where male participation (7.1 % and 7.4%) was higher than that of female participation (3.6% and 1.8%). On the other hand, female participation was higher for other fields.

3.5 Doctoral Studies

Figure 8 shows the number of students opting for doctoral studies during the six academic years on a gender and subject wise basis.

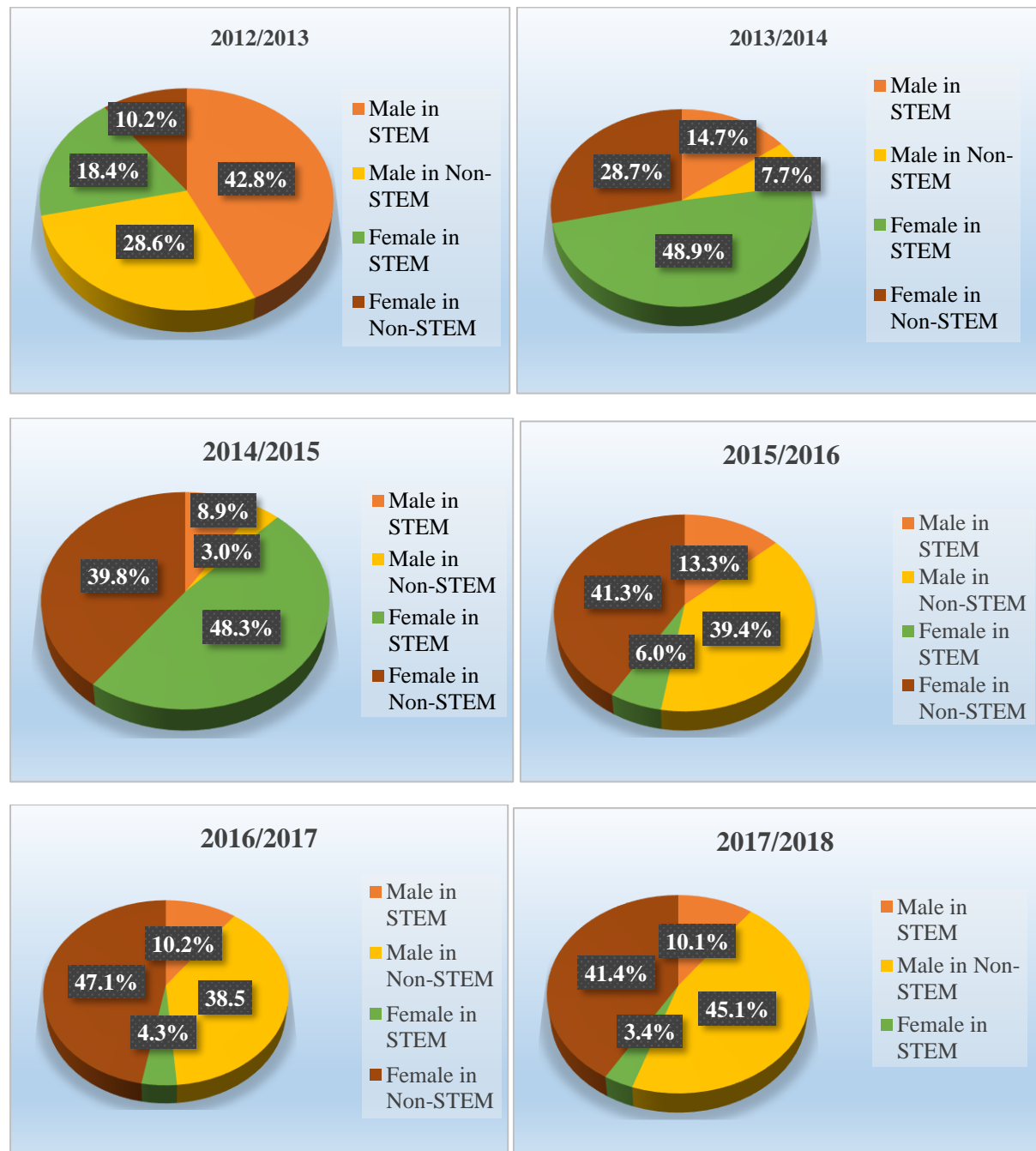


Figure 8. Percentage of male and female students at doctoral level (Tertiary Education Commission, 2012/2013-2017/2018)

It is clear that male participation in doctoral studies has been higher than female participation over the studied years for STEM and non-STEM subjects (except for the year 2013/2014 and 2014/2015).

3.5.1 Qualitative Analysis

38 doctoral students (19 females and 19 males) responded to the survey. The number of respondents in each category was as follows;

- i. Males in STEM: 14
- ii. Males in Non-STEM:5
- iii. Females in STEM:15
- iv. Females in Non-STEM:4

When asked about their intention to pursue a post-doctoral fellowship, respondents from the STEM sector were more interested (86-93% of respondents were positive) than those from the non-STEM sector (20-50% of interested respondents). Interestingly, most female respondents from the STEM sector were interested to pursue post-doctoral studies. The majority of doctoral students, irrespective of gender and field of study, were more interested to pursue an academic career.

When questioned about their reasons for choosing their field of study, the most popular response was passion and personal interest for the subject, irrespective of the field. All respondents had a good relationship with their supervisor irrespective of gender.

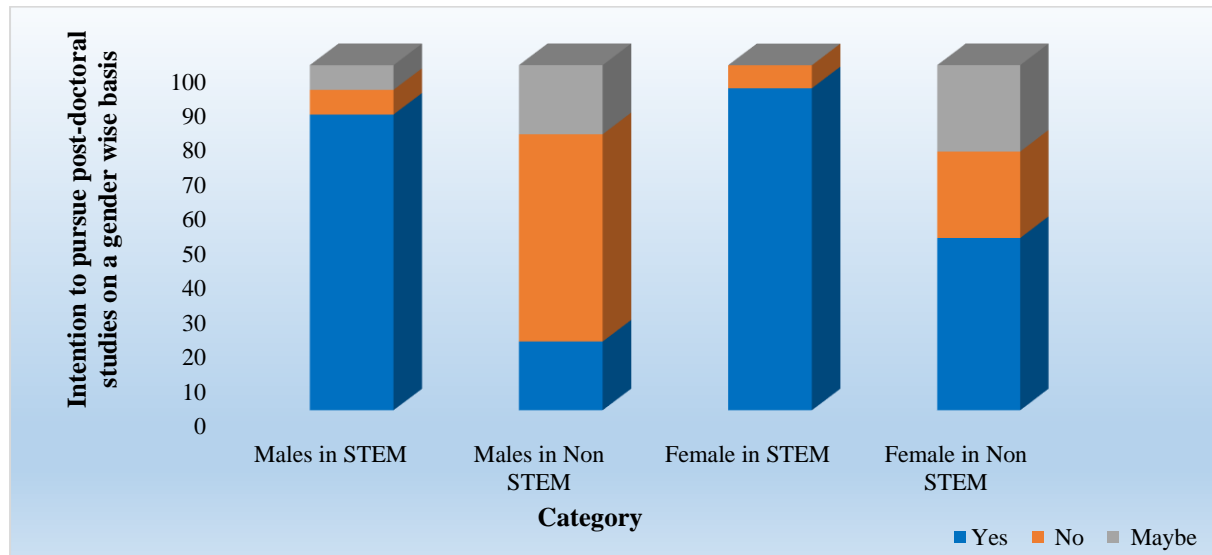


Figure 9. Intention to pursue post-doctoral studies on a gender wise basis

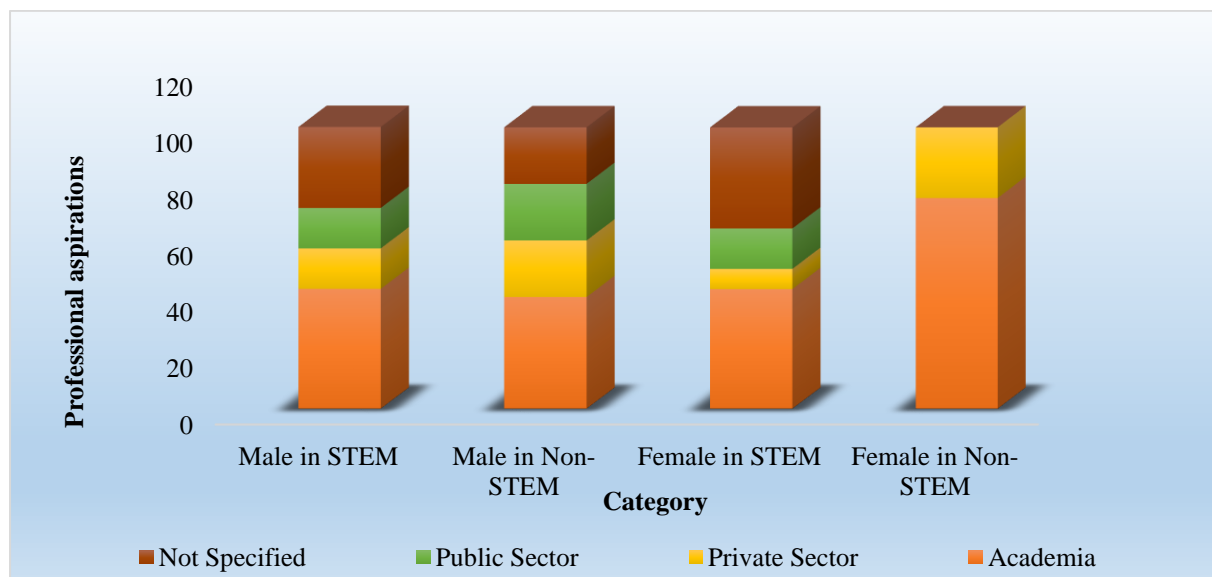


Figure 10. Professional aspirations on a gender wise basis

3.5.2 Analysis of Focussed group discussions

Table 4 illustrates the profiles of the women pursuing doctoral studies and their responses.

Table 4. Profiles and responses of interviewed female doctoral students

Name	Age Cohort	Year of Study	Field of study	Marital/ Relationship status	Most important factor(s) that influenced your decision in pursuing a PhD	Importance of gender of supervisor	Experience of Gender Bias in career	Achievements and Publications
G1	25-30 years	Fourth	Chemical and Environmental Engineering	Single	Family support	No difference observed	No gender bias	International collaborations with South Africa; seven publications
G2	25-30 years	Fourth	Physics with Computing	Married	Family support	No difference observed	No gender bias	International collaborations with many countries; has ten publications
G3	25-30 years	Sixth	Chemistry	Single	Family support	Easier to communicate with female supervisor	No gender bias	Had the opportunity to perform part of her project in Germany for a period of three months; has one publication (in process)
G4	25-30 years	First	Biomaterials and Tissue Engineering	Single	Family support	Easier to communicate with female supervisor	No gender bias	Had the opportunity to attend international conferences
G5	25-30 years	Second	Molecular nutrition	Engaged	Family support	No difference observed	No gender bias	Collaboration with Réunion Island; has one publication
G6	25-30 years	First	Organic and Computational Chemistry	Single	Family support	Easier to communicate with female supervisor	No gender bias	Collaborations with Spain; has eight publications
G7	25-30 years	Third	Marine Biochemistry and Cancer Chemotherapy	Single	Family support	Easier to communicate and is able to talk about informal things with female supervisor	No gender bias	International collaborations with many countries; three publications till now

Four out of the seven participants strongly highlighted that age or marital status should not deter women who wish to pursue doctoral studies. For all participants, family support was important.

One interviewee highlighted the need to balance her personal and professional lives. One participant, who was married, stated that she has to make many sacrifices to balance her family and professional lives. None of the women had encountered gender bias in their professional life; they all shared high confidence by highlighting that they strongly believe in their scientific ability.

4. DISCUSSION

4.1 Identification of gender gaps

Student profiles at secondary and tertiary education levels highlight the gender gaps that exist in STEM Education. Even if female enrolment is more than 50% in both secondary and tertiary institutions, the trend is reverse when it comes to enrolment in STEM subjects (female enrolment in STEM at O-level 15-17%; A-level:13-14% and at tertiary level:11.1-12.9%). The observed gender gap has persisted over the 6 studied academic years; similar reported observations in the nineties in Mauritius indicate that this trend has in fact been persisting for many years. The situation calls for actions to be taken, in that direction, particularly in this time when gender equity is a priority of the Post 2015 Agenda as defined by Goal 5 of the United Nations 2030 Agenda for Sustainable Development. Similar observations have been made in many countries, including 'developed' nations (Archer *et al.*, 2017; Quinn and Cooc, 2015). This gap has been attributed to many factors. These include gender stereotypes, cultural barriers including perceptions that girls have little aptitude for science, lack of self-confidence, gender bias on the job market, curriculum, school quality, teaching methodology (Haussler and Hoffman, 2002; Hill *et al.*, 2010, Tan *et al.*, 2013, Mujtaba and Reiss, 2013, Settles, 2016).

Interestingly Engineering and Information Technology are the two most popular fields of study among STEM students, probably because these fields lead to the highest paid jobs. Incidentally these are also the fields where male enrolment has been higher than female enrolment (Figure 7). When the gender profiles at secondary education are analysed (Figures 2, 3, 4 and 5), the percentage of girls opting for Physics and Design and Technology is lower than that of boys. At secondary level, there are more girls opting for Biology (Figures 2, 3, 4 and 5) and later for related fields such as Health Sciences, Agriculture and Medicine (Figure 7) at tertiary level. The gender gap in STEM Education is hence more acute in Physical and hard-core Sciences and is apparent as early as in secondary education. Similar trends have been reported in Great Britain, Netherlands and Egypt among other countries (Koblitz, 2016, Wyer *et al.*, 2014). Gonsalves (2014) account this gap to the 'inherent' tension between femininity and Physics and the constant struggle for women to be recognized simultaneously as women and physicists. In his study, it was found that the problem was existent at secondary education and cascaded to tertiary education level.

The persisting gender gap variation throughout secondary and tertiary education levels suggests that remedial actions should start early in the pipeline; this is consistent with the recommendation of O'Brien *et al* (2016) that interventions at middle school are important to increase girls' interest in STEM. According to Quinn and Cooc (2015), the leaky science pipeline may start as early as the third grade calling for actions even before the secondary education in primary schools. The interventions at early stage are recommended by Bond (2016) who reported that gender stereotypes shown on television influenced on girls' perceptions of STEM at the age of 6 to 9 years old. Further studies in the local context should probe into the primary education system as well. Further research is also required to identify the factors influencing the participation of girls/women in STEM Education. Gender stereotypes and the perception that science is too difficult for girls could be the main obstacle to lower women participation in STEM Education in Mauritius; sensitization of parents and family support were found to be potential measures to address the situation in this context. The interview conducted with doctoral female students in the present study still supports this finding; they all thought that family support was crucial even at this stage of their career. Hence, it can be concluded that family support could be the most important factor to encourage girls/women to pursue scientific careers.

4.2 Academic and Professional Aspirations

Doctoral studies are classified as a first step into a professional STEM career. Male enrolment as a percentage of total doctoral population has been constantly higher for doctoral studies (55.6-64.9%) than the female population (35.1-44.4%). However, this variation was wider for STEM fields than for non-STEM fields (Figure 8). Even if the causes are not investigated in this study, it can be extrapolated from other studies that pressure to settle down, gender bias and cultural barriers could contribute to this persisting gender gap (Haussler and Hoffman, 2002; Hill *et al.*, 2010, Tan *et al.*, 2013, Mujtaba and Reiss, 2013, Settles, 2016).

Interestingly, this study revealed that girls who embark on doctoral studies are as ambitious as the boys. The response is more pronounced in the STEM field where 93.3% of girls and 85.7% of boys expressed their intention to pursue post-doctoral studies. In terms of job preference, both gender showed equal interest to join academia, public or private sector, suggesting equal self-confidence in STEM. Girls in non-STEM sector (75% of female population) were more prone to pursue academic careers than the boys (40% of male population), more boys (20% of male population) were interested in public sector than girls (0 % of female population). These findings suggest

that the girls who pursue STEM studies tend to be as confident as the boys and they are very clear on their career objectives. The sample size in this study might have to be validated by larger sample sizes but the data do indicate some trends that might be interesting to investigate.

The girls who were interviewed in this study showed a high degree of professionalism and self-confidence and given the open nature of the interviews, they were free to express themselves on any specific factor. The focused group discussions revealed that the women have never encountered gender bias in their career at university level. This finding is different compared to experiences shared by other women in the STEM sector in other parts of the world (Koblitz, 2016, Robnett, 2016). These might be attributed to the different contexts in which the studies were conducted; for instance, some studies addressed the situation at professional and not at university level. At the same time the culture differs in different countries and hence this can lead to a variation to level of gender bias. Apart from cultural factors, a favourable academic institution-centered culture can also impact on gender bias (Khondker, 2001). This could be an indication that the University of Mauritius has promoted a positive culture and environment where the girls could thrive.

One major observation was the similar passion and confidence demonstrated by the doctoral students interviewed in this study. Similar observations have been made on attitudes of women scientists in the Middle East (Koblitz, 2016). However, unlike the experiences shared in the present study, women in that region of the world had encountered gender discrimination during their internships. In this study, the women clearly reported that they had not yet encountered gender discrimination in their career. The different cultural and social factors among countries might have led to this difference in response (Koblitz, 2016, Robnett, 2016). This is another indication of the positive culture the interviewed girls are evolving in, considering that cultural factors impact on the messages that girls carry with them regarding their confidence on their scientific abilities (Hill *et al.*, 2010). Consistently, all the interviewed girls reported the importance of family support in their career. It can be argued that it was only the girls with high confidence who pursued doctoral studies, those who leaked out of the system might have encountered stumbling blocks. This requires deeper investigation.

The degree to which the findings of this study can be generalized in the local context can be debated and further validation might be useful with larger sample sizes. However, the study certainly provides some indications on different trends and provides a first overview of female participation in STEM Education.

5. FINAL RECOMMENDATIONS

This study can be considered as a first of its type, as it involved both quantitative and qualitative analysis of STEM Education from a gender perspective throughout the secondary and tertiary education systems in the Republic of Mauritius.

The study clearly reveals gender gap variations in STEM Education, both at secondary and tertiary levels. This is more prominent for hard-core science such as Physics, Computer Studies, Engineering and Information Technology. It is also clear that male enrolment for STEM doctoral studies is higher than female enrolment. The study revealed high self-confidence in female doctoral students and they were as ambitious as male students were.

It is recommended that a full-fledged survey be conducted with a larger sample size of doctoral students to validate the indications obtained from this study on gender differences in career aspirations and on factors impacting on female enrolment in doctoral STEM fields.

It is further recommended that other segments of the STEM career pipeline be considered, for instance on the factors that could influence girls' tendencies to be interested in STEM at a younger age, at primary school. On the other end, a study on the career paths of women professionals after their graduation would be essential to close the loop and understand the real situation regarding gender participation in STEM in Mauritius.

Potential initiatives were identified to address the identified gender gaps at secondary and tertiary levels; these can be in terms on career advancement initiatives such as women STEM scholarships, networking and mentoring. It might be worthwhile exploring review of science curricula and pedagogical tools. Sensitization of the public and especially of parents can be a potential way to encourage their daughters to embark on scientific careers.

Gender mainstreaming in STEM Education is essential for women to participate fully in scientific advancement of the country.

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