An Examination of Gender Balance in ICT at Educational Institutions

The Research Unit

Policy Planning Development and Evaluation Division

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Preamble

The Information and Communication Technology (ICT) Division within the Ministry of Science and Technology (MST) is in the process of reviewing the national ICT Policy for the Jamaica. The Research Unit was asked to assist with determining how gender is balanced in Jamaica's ICT sector, with particular focus on the education system. The rationale being to determine if there is indeed a gender disparity that needs to be addressed in the revised policy.

On that basis, the Unit examined enrolment and graduation data disaggregated by gender for the following educational institutions/levels:

1. **Secondary Schools**: Students enrolled in CSEC[1] Information Technology (IT) and number of students with passes at Grades I – III.
2. **University of the West Indies (UWI)**: Department of Computing.
3. **University of Technology (UTECH)**: School of Computing and Information Technology (SCIT)
4. **Northern Caribbean University (NCU)**: Department of Computing and Information Sciences
5. **Vocational Training Development Institute (VTDI)**: BSc in Information and Communications Technology
6. **Scientific Research Council**: Information on National Innovation Awards

Each entity was asked to provide data for at least the last five academic years (from 2013/14 to 2017/18). Data were also examined on Gender Balance in ICT for other jurisdictions.

Where data were statistically compared, this was done using the Mann-Whitney U test for nonparametric data and the Student's *t* test for parametric data (normalised using log transformation with all assumptions being met). Statistical analyses were carried out using IBM SPSS Statistics 25 and Microsoft Excel 2016. The results are presented in subsequent sections.

[1] CSEC: Caribbean Secondary Examination Certificate

ICT Gender Balance at the Secondary Level

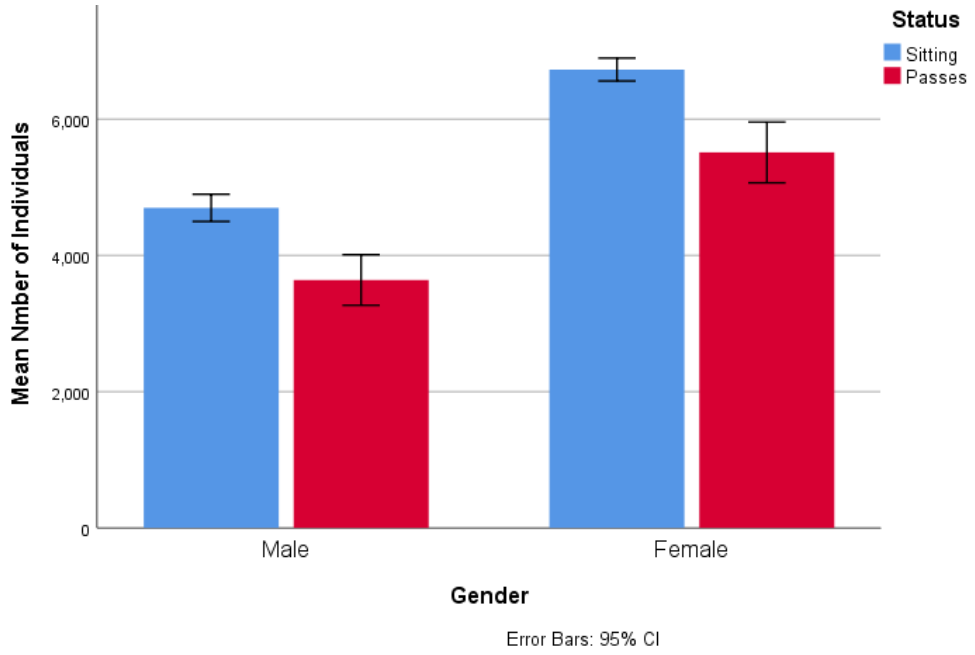
From the data received for 2013 to 2017, at the secondary level (Grades 10 & 11) the ratio of male to female for students enrolled in Information Technology is roughly 1 to 1. **Table 1** shows that at grades 10 and 11, for 2013 to 2017, the number of females slightly exceeds the number of males enrolled. The average number of males was 48% in Grade 10 and 49% in grade 11 for the five year period.

Table 1 Number of Males and Females enrolled in CSEC[2] Information Technology at the secondary level in the nation.

	Grade 10					Grade 11			
Year	Males	Females	Total	RATIO		Males	Females	Total	RATIO
2012-2013	9229	9905	19134	**0.93:1**		8986	9574	18560	**0.94:1**
2013-2014	11193	11893	23086	**0.94:1**		10341	10660	21001	**0.97:1**
2014-2015	9347	9512	18859	**0.98:1**		8845	9496	18341	**0.93:1**
2015-2016	9393	10576	19969	**0.89:1**		9088	9060	18148	**1:1**
2016-2017	9267	9957	19224	**0.93:1**		8400	9450	17850	**0.89:1**
TOTAL	**48429**	**51843**	**100272**	**0.93:1**		**45660**	**48240**	**93900**	**0.95:1**

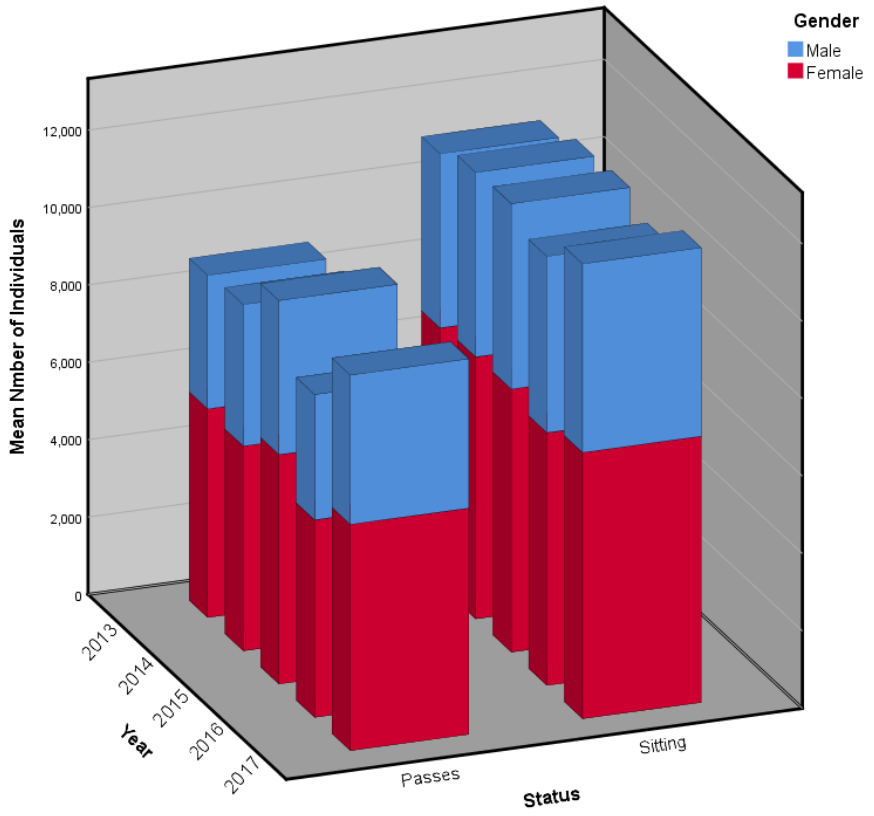
SOURCE: Annual Schools Census 2012-2016 (MOEYI[3])

As it relates to performance in the CSEC IT examination, the number of females who sat the exam, as well as the number that passed the exam was significantly higher than the number of males ($U = 15.0$; $p<0.01$). The mean/average numbers are shown in **Graph 1;** 4698 males and 6727 females sat the CSEC examination over the five year period with 3638 males and 5511 females passing.



Graph 1 Mean number of individuals sitting and passing the IT CSEC exam from 2013 to 2017 by gender.

[2] Caribbean Secondary Examination Council (CSEC)
[3] Ministry of Education, Youth and Information



Graph 2 Mean number of individuals who sitting and passing the IT CSEC exam by year and by gender from 2013 to 2017.

The results in **Graph 2** show the yearly data for mean number of males and females who sit and pass the IT CSEC exam yearly from 2013 to 2017.

Although the ratio of those who enrolled in IT at the CSEC level was about 1:1 (**Table 1**), the ratios differed for those sitting the exams. For the combined data from 2013 to 2017, the male to female ratio for those sitting the IT CSEC examination was 0.7:1, and 0.66:1 for those who attained passes of I – III in the exam.

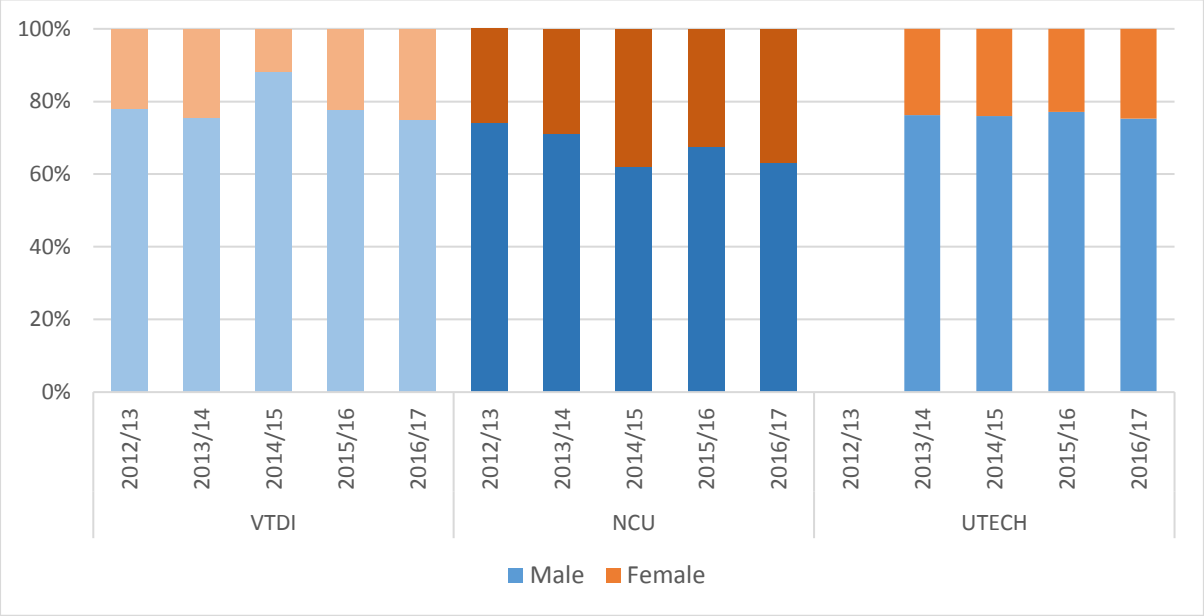
From analysis of the data, it was concluded that there is no statistically significant difference between the proportion of male and female passes in the CSEC IT examination from 2013 to 2017 (U=5,p= 0.117). The average pass rate from 2013 to 2017 is 77% for males and 82% for females.

ICT Gender Balance at the Tertiary Level

Data on enrolment and number of graduates were obtained for students in ICT at VTDI, NCU and UTECH, while for UWI, only information on number of graduates was received. The analyses revealed that the number of males was significantly higher when compared to females for both enrolment ($U=43.5$, $p<0.05$) and number of graduates (t_{34} = 2.95, $p<0.01$) across all institutions in all years combined.

Enrolment Data for Students in ICT

By institution, the percentage of females enrolled in ICT programmes was lower than the percentage of males in each academic year (**Graph 3**).



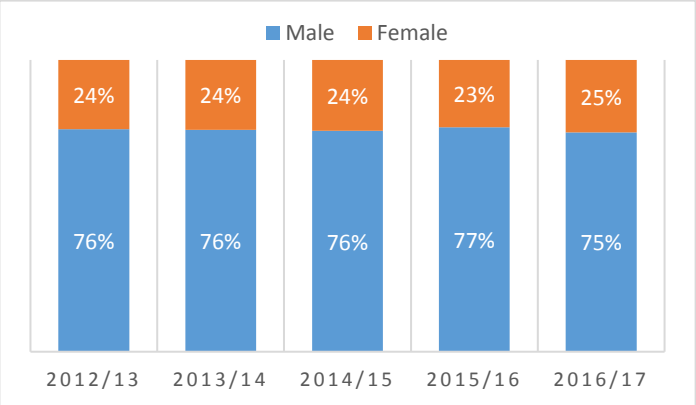
Graph 3 Proportion of males and females enrolled in ICT 2013 to 2017 at three tertiary institutions

Overall, enrolment data were not obtained for VTDI nor NCU; however, for UTECH which can be considered the leading university in ICT, females accounted for 58-59% of the overall school population in each academic year from 2013/14 to 2016/17. Although females outnumber males in general, the data in **Graph 3** show that only an average 24% of those enrolled in ICT at UTECH were females. For VTDI, the average percentage of females enrolled in ICT over five academic years was 21% and the average percentage for NCU was 32%.

Overall, from year to year, the overall ratio of enrolment in ICT for all three institutions was approximately three males to each female (**Table 2** and **Graph 4**).

	Total Enrolment		
Year	Male	Female	RATIO
2012/13	45	14	3.21:1
2013/14	1013	319	3.18:1
2014/15	962	308	3.12:1
2015/16	1049	314	3.34:1
2016/17	1045	346	3.02:1
TOTAL	**4114**	**1301**	**3.16:1**

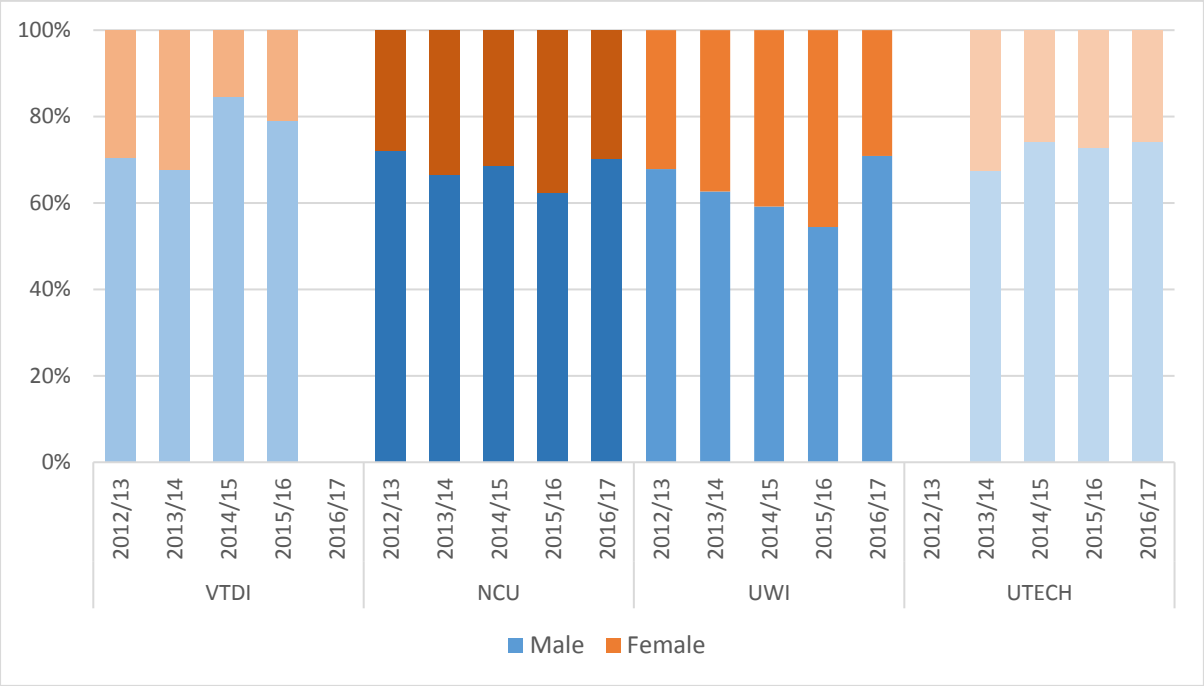
Table 2 Total number and ratios of males and females enrolled in ICT



Graph 4 Proportion of Males and Females enrolled in each academic year

Graduate Data for Students in ICT

The data were similar for the four tertiary institutions, with the percentage of females graduating with an ICT degree being lower than that of males. This would be expected in light of the ICT enrolment data for each institution. From the information presented in **Graph 5**, the highest percentages of female graduates were for UWI ICT graduates in 2014/15 and 2015/16.



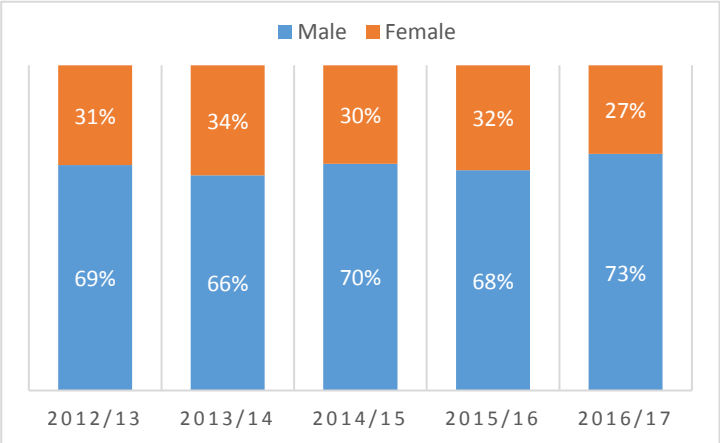
Graph 5 Proportion of male and female ICT graduates 2013 to 2017 at four tertiary institutions

On average, UWI had the highest percentage of females graduating over the five year period (37%); while females accounted for 25% of ICT graduates from VTDI, 32% from NCU and 28% from UTECH.

The data showed that male to female ratios and proportions were lower for the number of graduates (**Table 3** and **Graph 6**) as compared to those for enrolment. With the average ratio being two males to each female for ICT graduates, this suggests that although the gender disparity is higher at the point of enrolment, there is some improvement at the point of exit from ICT programmes.

	Total Graduates		
Year	Male	Female	RATIO
2012/13	95	42	2.26:1
2013/14	198	101	1.96:1
2014/15	203	88	2.31:1
2015/16	193	92	2.1:1
2016/17	203	76	2.67:1
TOTAL	**892**	**399**	**2.24:1**

Table 3 Total number and ratios of male and female ICT graduates



Graph 6 Proportion of Males and Females graduating with ICT degrees in each academic year

Undergraduate and Postgraduate ICT Students

Data were available for those graduating with undergraduate and postgraduate degrees for NCU, UWI and UTECH. The analyses examined how gender is balanced at these two levels; data for postgraduates from UWI were unavailable for 2016/17. The male to female ratios are shown in **Table 4** for both undergraduate and postgraduate.

	Undergraduate					Postgraduate			
Year	Male	Female	Total	RATIO		Male	Female	Total	RATIO
2012/13	151	68	219	2.22:1		28	16	44	1.75:1
2013/14	150	54	204	2.78:1		38	25	63	1.52:1
2014/15	173	67	240	2.58:1		28	27	55	1.04:1
2015/16	159	80	239	1.99:1		16	7	23	2.29:1
2016/17*	80	33	113	2.42:1		10	1	11	10:1
TOTAL	**713**	**302**	**1015**	**2.36:1**		**120**	**76**	**196**	**1.58:1**

*Data absent for UWI Computing 2016/17

Table 4 Total number and ratios of male and female ICT graduates at both undergraduate and postgraduate level; combined data for UTECH, NCU and UWI.

The difference in the total number of males and females who obtain undergraduate degrees in ICT from all institutions was highly significant (t_{26} = 3.18, p<0.01,) where males significantly outnumber females With data being absent for 2016/17 from UWI, that data for that academic year was excluded and the analysis yielded no significance in the difference between number of male and female graduates at the postgraduate level.

The performance of female computer science students was assessed for UWI's three campuses across the Caribbean and it was only in Jamaica that the GPA of females in the Department of Computing was significantly higher than that of males (Fokum, Coore, & Lewis-Fokum, 2016). Additionally, Fokum, Coore and Lewis-Fokum (2016) highlighted that the dropout rate of females in ICT programmes was probably not a significant contributor to the high bias towards males graduating. The data presented in Tables 2 and 3 above support this, where male to female enrolment ratios are higher than the ratios observed for number of graduates.

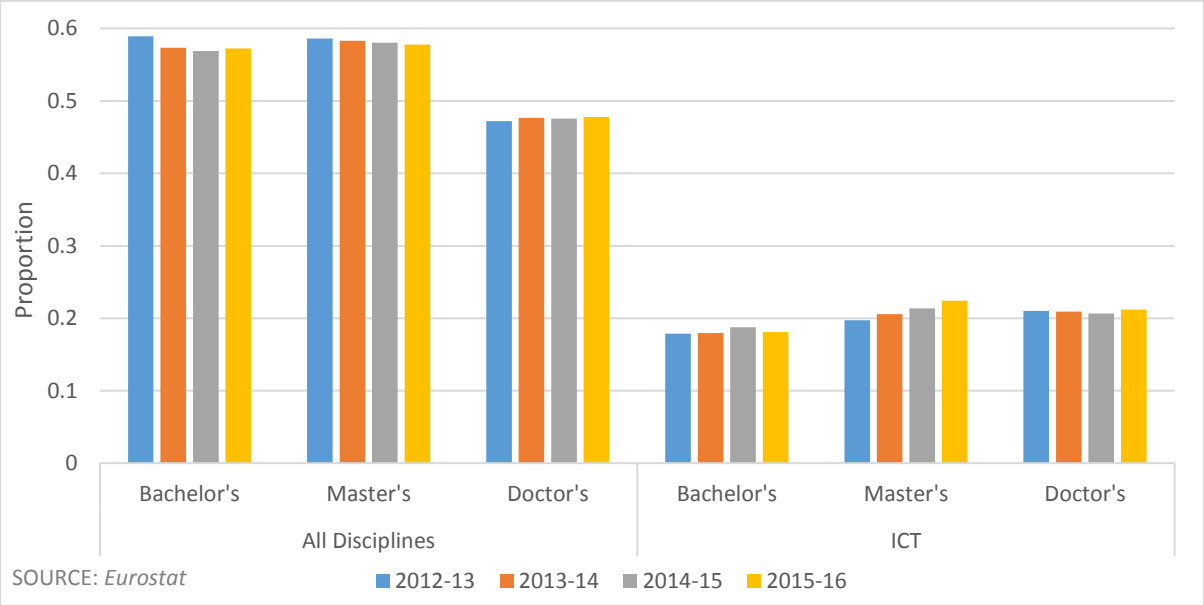
ICT Gender Balance at all Educational Levels Globally

In order to determine if the data as described above are similar to trends seen globally, the gender balance in ICT was examined for other locations globally. The data for these other jurisdictions only reference number of students who have graduated.

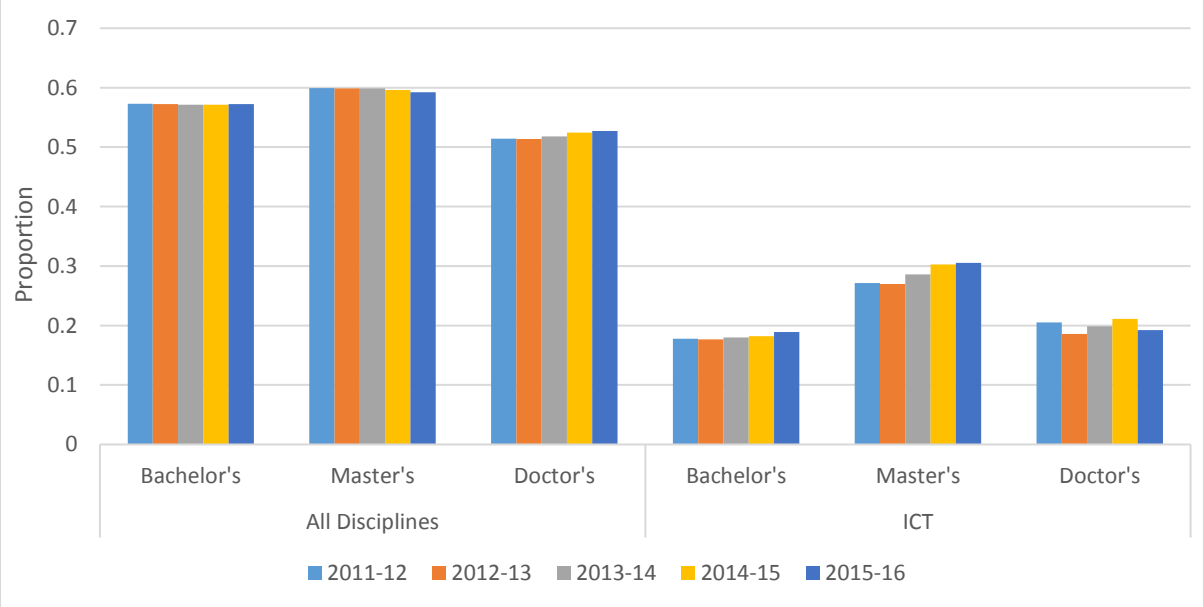
From the data presented on the European Union and USA in **Graphs 7** and **8**, for all disciplines the proportion of females was greater than or about equal to 0.5 (50%) when compared to the proportion of males graduating. This is similar to the general situation in Jamaica where females outnumber males at the tertiary level of education leading to more females graduating. From 2010/11 to 2015/16 at UWI Mona, an average of 67.6% of students enrolled were female in comparison to 32.4% males; the graduation percentages are likewise similar.

When the degrees conferred for ICT disciplines are examined, in both the EU and USA, only about 20% of those graduating with a Bachelor's or Doctoral degree are females. For Master's degrees, the percentage is also ~20% for the EU while being ~30% for the USA. Therefore, the trends are similar to

what the data for Jamaica have previously shown where there are more males in ICT disciplines, however for Jamaican ICT postgraduates, the bias towards men is not as strong.



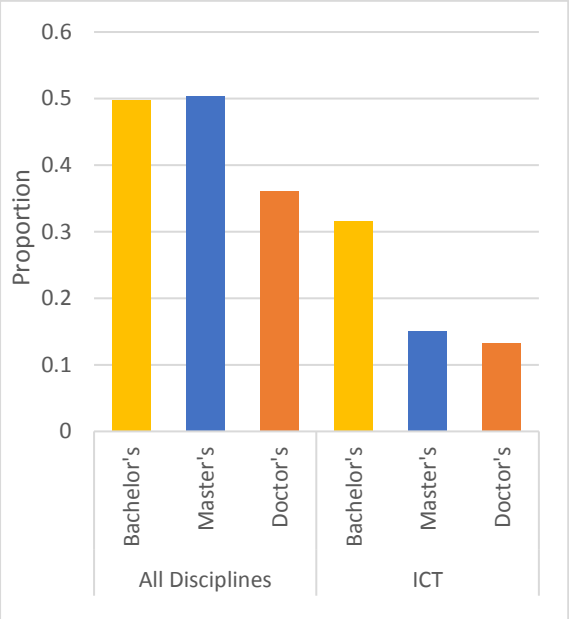
Graph 7 Proportion of Females by Degree Type for All Degrees Conferred vs ICT Disciplines for the European Union



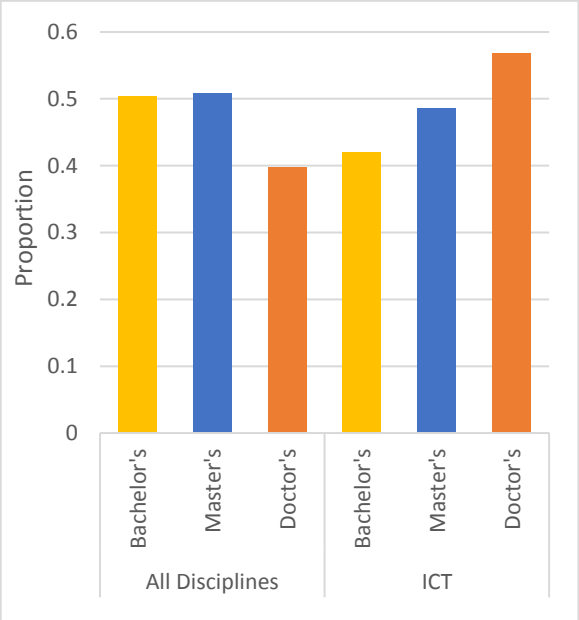
Graph 8 Proportion of Females by Degree Type for All Degrees Conferred vs ICT Disciplines for the United States of America[4]

[4] SOURCE: U.S. Department of Education, National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Fall 2012, Completions component. (This table was prepared July 2013.)

South Korea and India were also examined as two OECD countries; however, data were available only for 2015; insufficient data presents a limitation in this instance (**Graphs 9** and **10**).



Graph 9 Proportion of Females by Degree Type for all Degrees Conferred vs ICT Discipline for South Korea



Graph 10 Proportion of Females by Degree Type for all Degrees Conferred vs ICT Discipline for India

The trend in South Korea is similar to Jamaica, US and the EU, wherein there are fewer females by proportion in ICT disciplines as compared to all disciplines. Differences are however observed in the proportion of females in each discipline. Approximately 30% of those with undergraduate degrees in ICT are females; this is higher than observed for the EU and US, while being similar to what is observed in Jamaica. The gender disparity is greater however for South Korea at the postgraduate level for ICT, with about 10-15% of females being qualified at that level.

The data from India presents a unique case. Females accounted for at least 50% of all graduates at the Bachelor's and Master's level, while accounting for ~40% at the doctoral level. The proportion for the ICT disciplines however, were unlike what has been observed in Jamaica and the aforementioned countries. In India, the proportion of females increased from 42% with Bachelor's degrees to 48% with Master's and formed the majority at 57% with doctoral ICT degrees. This indicated that at the highest level, females appear to outperform males in ICT disciplines in that country.

India is considered to be a developing country and in that regard they are similar to Jamaica; however, the rapid growth of India's ICT sector has surpassed not only Jamaica but the rest of the developed world. From 2000 to 2004, the Indian economy grew by 6.2% and from then to 2014 grew at an average annual rate of 8% as it became the world's leading exporter of software services (Bartolome, 2014). The growth in the ICT sector has led to an increase in job opportunities and it is therefore no surprise that more persons would gravitate towards obtaining these degrees, not excluding women.

ICT Gender Balance in Jamaican Innovations

The current national ICT policy addresses the importance of innovation. In light of this, the data from the National Innovation Awards were examined to see gender balance based on entrants into the competition, as well as winners. The biennial competition, which was first held in 2005, is hosted by the Scientific Research Council, an agency of the Ministry of Science and Technology. Data regarding the number of entrants by gender were available only for the 2014 and 2016 (2018 competition not yet held).

The ratio for those entering the competition was approximately four males to each female for 2014 and 2016 (for 2016 two couples entered) and this represents a percentage of ~80% males to ~20% females entering the competition for these two years. Based on the gender balance for the number of entrants, it was not unexpected for gender disparity to be observed for the winners. Table 5 gives information on the number of winners by gender for all six instances when the competition was held. Company entries were excluded from gender consideration and where couples participated, these were factored into the overall male and female numbers.

YEAR	MALE	FEMALE	COMPANIES	M:F RATIO
2016	9	1		**9:1**
2014	9	2		**4.5:1**
2012*	2	1	2	**2:1**
2010	2	0	2	**2:0**
2008	6	1	1	**6:1**
2005	2	2	1	**1:1**
TOTAL	**30**	**7**	**6**	**4.29:1**

Table 5 Number and ratio of male and female winners in the National Innovation Awards

Conclusion

From the data examined it can be concluded that student enrolment in Information Technology at the secondary level is gender balanced at approximately one male to one female. However, a significantly higher number of females actually sit the final examinations. Although the percentage of females who are successful in the examination is higher than that of males, the analysis showed that this difference was not statistically significant. Attention should be given to understanding the reasons which negatively influence a male student's decision to sit the examination after being enrolled. This is likely the source of the gap observed in the ICT examination results presented in this study.

Unlike what was observed at the secondary level, there is a shift in gender balance at the tertiary level, with more males being enrolled in and graduating from ICT disciplines across the tertiary institutions examined. The difference in numbers between the genders was found to be highly significant at the undergraduate level (Bachelor's) but not significant at the post-graduate level (Master's and Doctorate). This suggests that at the highest level, there is little cause for concern regarding females in ICT but at the undergraduate level which produces the highest number of ICT certified professionals, the 3:1 male to female ratio is a point of concern. From a policy perspective, the area of interest would be to understand why comparatively less females are enrolling in tertiary level ICT disciplines, even though significantly more females are qualified to matriculate in the area of study based on more CSEC passes.

The gender disparity in Jamaica was observed to be similar to other jurisdictions, namely the US, EU and South Korea. The unique case of India however, is a good example of how a country which prioritises ICT at the national level is able to influence both males and females to equally pursue qualifications within this discipline.

From the data shown, it can also be inferred that more males are playing an active role in innovations as compared to females, with an average male to female ratio of 4:1 for entrants and winners. This ratio is higher than what was observed at the tertiary education level and suggests that fewer women are using their expertise innovatively.

With all that has been presented in this paper, the final conclusion is that there is indeed a need for the revised national ICT policy to address gender balance in Jamaica's ICT landscape.

References

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Fokum, D., Coore, D., & Lewis-Fokum, Y. (2016). The Performance of Female Computer Science Students across Three Caribbean Islands. *SIGCSE*, *16*, 419–424.

Acknowledgements

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