Exploring Female Enrollment and Outcomes in Chemical Engineering and their Experiences in Pursuit of a Career in STEM

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***Abstract*— The need for more engineers in Jamaica has increased in recent times. Recognizing that females are underrepresented in science, technology, engineering, and mathematics (STEM), more efforts are being made to encourage females to pursue careers in STEM. Although engineering continues to be male dominated, there are a few engineering disciplines with relatively high female participation. Chemical engineering (ChE) is one of these engineering disciplines. In this study, gender differences in enrollment and persistence in ChE, the quality of degree obtained on completion and the job placement of female graduates were investigated. A survey was used to obtain qualitative information on factors that influence females to study ChE, and their gender-related experiences as students and STEM employees. The main findings revealed that females represented 41% of ChE intake, had higher rates of degree completion, were motivated by male role models to pursue engineering, and few females experienced some forms of gender-based discrimination in STEM employment. Based on the study, strategies were suggested to improve the number of females in STEM and to address the issues of gender bias in STEM employment.**

***Index Terms*— Chemical engineering, enrollment, gender bias, graduation rates, persistence.**

I. Introduction

FEMALES represent 50.5% of the Jamaican population [1]; however, they are underrepresented in top managerial positions in companies and in government. The current Cabinet had only 4 females representing 23.5% of the ministerial incumbents. The low involvement of females in significant employment positions might be linked to societal or stereotypical influences that dictate what females can or cannot do. For example, the pursuit of a career in science, technology, engineering, and mathematics (STEM) has been stereotypically promoted as unsuitable for females [2, 3]. Parental and teacher expectations of children at an early age orientate females toward careers in education and health and males toward STEM [4]. While females are the majority in medical and health science degrees and occupations, they are still underrepresented in most STEM fields that require intense mathematical applications [5]. With rapid advancements being made in science and technology, forecasts of the future job market indicate a demand for STEM talents [4, 6]. From an economic viewpoint, not engaging more females, who constitute half the population, in STEM could threaten global competitiveness [7]. Locally, a dearth of information exists on the number of females who are enrolled in engineering programs and who have STEM occupations. Based on this, a project was developed in the School of Engineering at the University of Technology, Jamaica (UTech, Ja.) to document information on females in engineering in Jamaica. In this context, the chemical engineering (ChE) program was selected as the pilot program. This paper expands on a study by Henry, Hall and Plummer [8] in which enrollment numbers and outcomes for female graduates in ChE were investigated. This paper contributes to the work in the following ways:

1) Insights into the factors that might affect persistence of females have been provided.
2) Current issues of gender stereotypes and biases in STEM employment have been highlighted.
3) Strategies to address gender-related issues in STEM/engineering education and employment have been proposed.

II. Background

The ChE program is one of five undergraduate engineering programs in the School of Engineering (SOE) at UTech, Ja. The others are mechanical, electrical, civil, and industrial engineering. To enter the ChE program, applicants are required to satisfy the minimum requirement of the university and have passes in pure mathematics, physics, and chemistry at the advanced level. Applicants with SAT scores or with previous enrollment in a technical or science-based program can be admitted after a detailed review of their transcript. Other entry routes include completing the first year of a diploma or

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associate degree in an engineering program with a qualifying Grade Point Average (GPA). Applicants with a science- or technical-based diploma can also be admitted to the program and be given advanced placement. The degree has a range of 133 – 136 credits and, apart from core ChE and general education courses, students can select electives from one of three specializations: process engineering, environmental engineering, and biotechnology. In addition, students are required to complete 400 hours of industrial work experience to graduate. Graduates can receive one of the four classifications of degree used by UTech, Ja.: First-Class Honors, Upper Second-Class Honors, Lower Second-Class Honors, and Pass. Students can complete the degree in 4 years (prescribed time) or within a maximum of 7 years (permissible time).

The first intake to the ChE program was in 2002 and it caused a noticeable change in the School of Engineering – it included a significant number of females. The number of females enrolled in the UTech Ja. ChE program since its inception has been minuscule when compared with the large numbers recorded at universities in the United States (U.S.). The same applies to the other local engineering programs and the number of male students as well. The wide disparity in student numbers in engineering between Jamaica and the U.S. might be because of the differences in population size and economic diversity. However, males continue to outnumber females in the various engineering disciplines regardless. Hence, more needs to be done to close the gender gap in engineering.

The primary objective of this paper was to explore the factors that motivated females to enroll and persist in an engineering degree program, and the gender-related challenges they faced during their study and employment.

III. Review of Related Literature

It has been suggested that females are less interested in studying mathematics and science because they do not plan to work in these areas [9]. This lack of interest in STEM careers might be because of societal stereotypes [10], parental expectations and teacher influence [4]. STEM-related research has indicated also that females are excluded at higher rates than males from classroom activities that serve as positive predictors of aspiration to a career in STEM [10]. Wang and Degol [5] reviewed the cognitive, motivational and sociocultural factors that contribute to the gender gap in STEM. Considerations were given to explanatory factors that included gender-related stereotypes and biases, cognitive ability and strengths, occupational interests, and work-family balance preferences. When these factors are imposed, most females, even those who are mathematically gifted, choose a non-STEM career path. The researchers recommended the involvement of policy-makers and practitioners to remove the restrictions of cultural barriers, gender stereotypes and misinformation to increase the number of females in STEM.

Studies that have been done on persistence in undergraduate engineering programs where data were disaggregated by gender include work done by [2, 11-15]. Kamphorst et al. [11] reported that 77.3% of female engineering students in Australia, who started in 2004, completed after eight years; males completed at a rate of 68.7% within the same period. Lord, Ohland and Layton [14] carried out a to investigate enrollment and persistence in several engineering disciplines in the U.S. They found that ChE was the only discipline where males graduated at rates approximately 27% higher than females. ChE also had the highest attrition rates (greater than 30%) for both genders. Brawner et al. [16] identified relationships with peers and faculty as an important factor influencing female persistence in ChE. The unwillingness to give up because of effort exerted was another reason for persisting. While females are still underrepresented in engineering, Roy [17] reported that, from 2009 to 2018, the percentage of degrees awarded to females in the U.S. has increased consistently from 17.8% to 21.9%.

University graduates with higher degree classifications are more likely to receive better employment opportunities and secure postgraduate placement than graduates with lower degree classifications [18]. Madara and Namango [19] investigated graduation outcomes for students in five engineering disciplines at a Kenyan university for the period 2003 - 2014. Their findings showed that for the chemical and processing engineering program, 11.7% of males were awarded First-Class Honors compared with 5.8% of females. Most females (94.2%) and males (87.0%) received awards in the Second-Class Honors divisions, and only males received Pass awards. Similar findings were reported in 2012 for an analysis of bachelor's in engineering degrees awarded to graduates in the United Kingdom (U.K.) [20].

Although there has been an increase in the proportion of females graduating with a STEM degree, as observed in the U.S. [21], the number of females working in STEM/engineering fields continues to be low [4, 7]. From Canada's 2016 census data, 62% of females who studied STEM never worked in an area that related to their educational qualifications, with only 20.2% persisting in a STEM occupation [22]. Outside of STEM, females were employed in areas including sales, marketing, advertising, retail trade and administrative services [22]. In a study done by Smith [23] on the engineering cohort that graduated in 2008 in the U.K., it was found that 60% of female graduates were employed; nine percent (9%) of the female cohort were unemployed and 11% moved on to pursue postgraduate studies. Of the employed females, only 32% were working in engineering. Other fields identified by Smith [23] included teaching (1%), business (2%) and sales (7%). A more recent study, the Royal Academy of Engineering [20] revealed that only 30% of the 2012 female graduates from research-based universities in the U.K. were in full-time engineering employment, which was 17% lower than their male peers [20]. This low involvement of females in engineering employment was also observed in the U.S. Sassler et al. [21] reported that 45% of women in the U.S, who majored in engineering, were working in engineering occupations at the time of their investigation.

Females might face negative stereotypes when they are the minority in a male domain [2]. Although practices of discrimination are not as widespread as they were years ago [2, 5, 24], elements of sexism remain [5]. Madara and Cherotich [25] reported findings of female engineering students facing

numerous gender-related challenges and harassment from teachers and classmates. Rincon et al. [26] investigated workplace biases in engineering employment in India. Findings revealed that, while females experienced gender biases, males were discriminated against based on language spoken and their place of origin. According to the findings of Funk and Parker [27], 50% of women in STEM jobs indicated that they have experienced at least one of the several forms of gender-based discrimination in the workplace. Being denied a promotion, treated as incompetent and receiving less support from supervisors compared with male counterparts were among the types of discrimination experienced.

IV. Method

A mixed-method research design was used for this exploratory study. The first stage of the research was a quantitative cohort analysis [8] and captured information on enrollment, persistence and quality of degree awarded according to gender, and the job placement of female graduates. Persistence was documented as both 4-year completion (prescribed time) and 7-year completion (permissible time). The data for the cohort analysis were extracted from documents and student database management systems. Only students enrolled in ChE from academic year 2004/2005 to 2015/2016 were included. Considering that different trajectories can be taken for degree completion, the percentage of degrees awarded to females in ChE, each year from 2008 to 2019, was examined and compared with similar information for the U.S. and the University of Florida where data were available.

The second stage of the research was qualitative and served to add depth to the trends observed in the cohort analysis. A survey consisting of five sections, with a total of 40 items, was used. Pre-set answer options and open-ended response items were used. The items were designed to explore the following:

1) Reasons for females to select and pursue a degree in ChE;
2) Factors that contributed to degree completion and quality of degree obtained;
3) Gender biases experienced during their course of study and in STEM employment;
4) Reasons for females not to seek or to leave STEM employment; and
5) Perception of their choice of engineering degree program.

An online survey instrument was developed using Google Forms and the link was sent be email to females who were enrolled in the program across the different cohorts used in the study. A total of 41 females completed the survey.

All ethical protocols were followed as outlined in the university's research policy in the undertaking of this research.

V. Results

The findings on enrollment, persistence, awards, and graduate employment obtained from the method of document and database review have been presented first. Then findings from the survey instrument follows.

TABLE I
ChE cohort enrollment by gender and F/M ratio

Entry Year	Females	Males	Total	F/M ratio
2004/05	5	12	17	0.42
2005/06	8	11	19	0.73
2006/07	4	11	15	0.36
2007/08	16	28	44	0.57
2008/09	14	22	36	0.64
2009/10	12	13	25	0.92
2010/11	9	6	15	1.50
2011/12	10	12	22	0.83
2012/13	13	13	26	1.00
2013/14	9	18	27	0.50
2014/15	4	7	11	0.57
2015/16	8	9	17	0.89
Total	112	161	273	0.70
Percentage	41.0	59.0	100.0	

A. Document and Database Review

1) Enrollment in ChE

The number of entrants to ChE, disaggregated by gender, is shown in Table I. The enrollment numbers in the program were low with the highest of 44 recorded in 2007/2008. The female to male (F/M) ratio listed was 0.36 and above, with 2010/2011 and 2012/2013 having ratios of 1.00 and 1.50 for female participation, respectively. The mean enrollment for females was 41%.

2) Persistence in ChE

Fig. 1 shows the percentage of entrants who persisted to degree completion. As can be seen from the graph, earlier cohorts (2004/2005 and 2005/2006) had 100% completion with a general decline observed thereafter. The mean percent completion was 82% and the minimum was 63%. Examining persistence further by gender revealed that females (86%) persisted at higher rates than males (74%). Attrition rates from the program were low, below 30%, with females being less likely to leave than males. In terms of completing the degree within the prescribed time, females were also outperforming males. Fig. 2 shows the outcomes of persistence for enrolled students. As can be seen, 64% of females completed the degree in 4 years, while 44% of males achieved this milestone. Overall, 52% of the entrants completed in 4 years and a total of 77% persisted when the maximum time was used.

Table II shows the percentage of degrees awarded to females in ChE from 2008 to 2019 in the U.S., and at UF and UTech, Ja. Data from gender studies carried out in universities in the region, if any, were not made public. Therefore, data from the U.S. were used instead. UTech, Ja. displayed fluctuation in the number of degrees awarded to females over the period, similar to the trend observed for UF. The average number of degrees awarded in the discipline in the U.S. has remained relatively the

same except for the dip recorded in 2014. Overall, Utech. Ja. awarded a higher mean percentage (44%) of degrees in ChE to females than UF (29%) and the U.S. (31%).

3) Quality of Degree

The number and quality of degree awarded are shown in Fig. 3. The finding indicated that most graduates (71%) obtained a degree in the Second-Class Honors categories. Females received twice as many First-Class Honors awards as males, performed on par with males in the Upper- and Lower-Second Honors categories and received less Pass awards than males.

4) Job placement after graduation

Table III shows the job placement of female graduates within the first year after graduation. Based on the nature of operations conducted and the number of employees, STEM organizations are categorized according to the first three descriptions shown in the Table. Large manufacturing/engineering companies had the largest placement of female graduates at 32.9%. This category includes industries such as petroleum refinery, rum processing, and alumina.

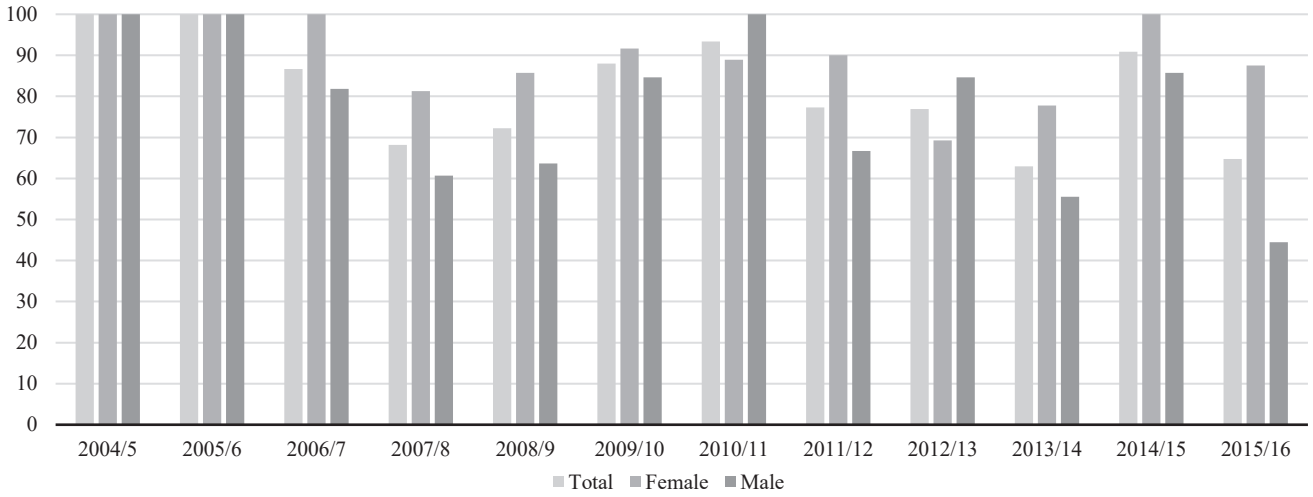

Fig. 1. Persistence rates of total enrolled students, females and males

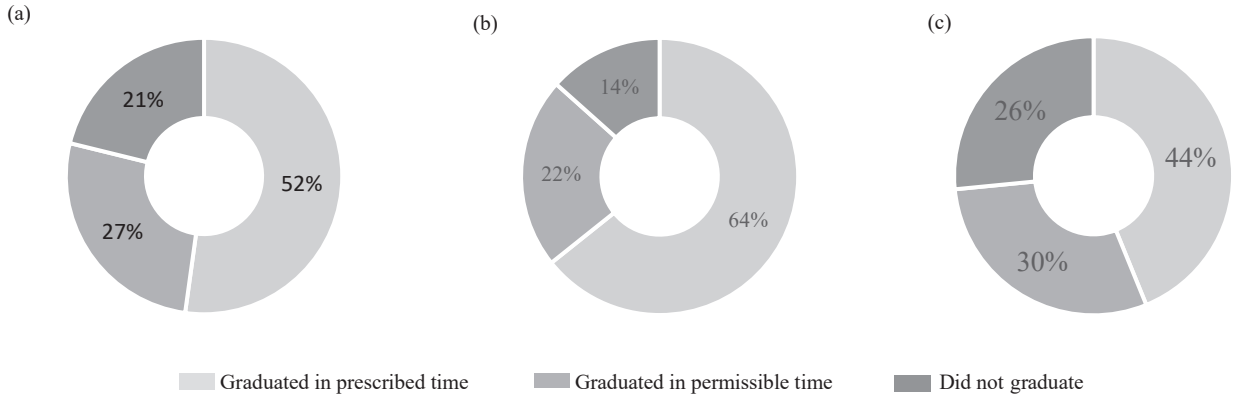

Fig. 2. Persistence outcomes for the 12 cohorts of ChE students (a) Total enrolled (b) Females (c) Males

TABLE II
PERCENTAGE OF CHE DEGREE AWARDED TO FEMALES NATIONALLY, AT THE UF AND IN THE U.S. FROM 2008 TO 2019

Graduation year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
U.S. [a]	33	33	32	31	30	30	24	33	33	-	-	-
UF [a]	15	23	28	36	34	25	33	31	36	-	-	-
UTech	20	38	58	43	48	50	56	47	46	47	33	47

[a] Data for U.S. and UF have been extracted from [28] for the years 2008 to 2014 for U.S., and to 2016 for UF.

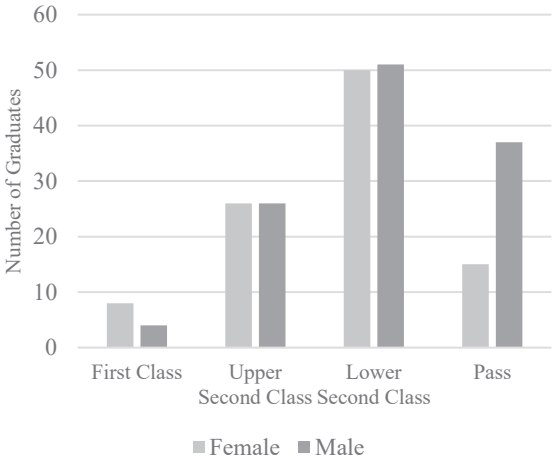

Fig. 3. Degree classification in ChE for the 12 cohorts

TABLE III
EMPLOYMENT PLACEMENT OF FEMALE GRADUATES

Placement	Percentage
Large manufacturing/Eng. companies	32.9
Small/Medium manufacturing companies	13.8
Small engineering consulting firms	2.1
Government agencies	10.6
Education (Secondary)	9.6
Unrelated/Business and finance	9.6
Graduate School	5.3
Unemployed	7.5
Unknown	8.5

Overall, 59.4% of female graduates obtained placement in a company or agency with STEM applications. The ChE field was also losing potential female employees to teaching and business-related occupations.

B. Survey Results

The survey questions asked were in the domains of motivation for pursuing a career in engineering, persistence in engineering, academic performance, employment, and gender-related experience in engineering.

1) Motivation for a career in engineering

Many participants gave similar responses when asked what motivated them to enroll and pursue a degree in engineering. Four motivating factors emerged, namely: (i) love of chemistry, mathematics, and science, (ii) male relatives as role models, (iii) influence of teachers and counsellors, and (iv) exposure to the STEM industry. The following is a statement from one participant explaining her motivations:

> I pursued a degree in engineering because I was inspired by my uncle who was also an engineer. I also had an affinity for mathematics and the sciences in high school and I felt that a career in engineering would allow me the opportunity to explore these interests.

Some participants also expressed the benefits that engineering offers in terms of understanding the physical world and applying problem-solving and critical-thinking skills. Others also indicated their love for the challenges that a career in engineering offers. However, not all the participants had initial plans to pursue a career in engineering. Twenty-six (26) participants indicated that engineering was their second choice. Careers in medicine, pharmacy, teaching, food and beverage and cosmetology were among the preferred options. Reasons for change in career option included not meeting the entry requirements, lack of financial resources to pursue first option, low remuneration, and family influences. One participant described her first choice and reason for career option change as follows:

> I wanted to become a food and beverage manager. However, my father did not think very highly of the food industry so I went with the next best thing that my chemistry teacher suggested.

The participants were asked also to indicate at what education level they were exposed to STEM that contributed to their consideration of a career in engineering. Thirty-nine (39) participants indicated exposure in secondary education or high school, with 'upper' secondary being the main level of exposure for 27 participants. The remaining two participants indicated primary school.

When asked about their choice of engineering discipline, 33 participants indicated ChE as their first choice. Their love of chemistry contributed to this selection. Biomedical engineering, CVE, and EE each had two participants indicating them as first choice, while computer engineering and ME had one participant each. The preference for ChE was more of a personal choice for most participants (25) but influences of relatives and friends with engineering degrees were also noted. Only seven participants indicated that their decision was influenced by parents without engineering degrees. Most participants (29) did not have practicing female chemical engineers as role models.

2) Persistence to degree completion

Questions placed in this domain were used to identify personal reasons that influenced females in completing or not completing the degree. All participants (41) indicated that they completed their degree. As such, this prevented the study from gaining insights into reasons for not persisting to degree completion. Of the 41 participants, 35 completed within the prescribed time. These participants gave responses that included: a personal goal to complete within the prescribed time; being on a scholarship that required a good GPA for continuance; and the need to complete on time to allow a younger sibling the same opportunity when parents were financially responsible for tuition fees. The remaining six participants indicated that the extended stay in the program was the result of: taking leave of absence due to family obligations (2); repeating modules (3); and for those who were working students, clashes between work and school (1).

Most participants also expressed that financing of their tertiary education was influential in their persistence. Only six participants were self-financing. The others relied on scholarships and grants, student loans, and their parents and relatives.

3) Academic performance

Participants were asked to indicate the quality of degree received on completion and to state factors that contributed to their academic performance. Five (5) participants received First-Class Honors; 18 received Upper-Second Class Honors; 12 received Lower-Second Class Honors; and 6 received a Pass award. Among the responses given for contributing factors were: having good mental health; comfortable living environment; practicing good time management; independent studying; and the use of study groups. While 39 participants indicated using study groups, 24 found study groups to be effective less than 50% of the time. Participants also stated that consultation with lecturers contributed to their success, with most finding consultation useful (95%) and accessibility of lecturers (90%). Participants also indicated that peers were as important as lecturers in their understanding of course material, with a higher number preferring to consult their peers when seeking clarity on content. Attending classes and tutorial sessions frequently were also listed.

4) Employment in STEM

To obtain a better understanding of opportunities in employment, participants were asked to indicate the job description and length of time it took to obtain employment in the field. Of the 41 participants, 26 indicated that they obtained employment within a year of degree completion; 14 were unsuccessful in achieving this; and one participant went on to graduate school. The majority of the employed graduates (23) stated that they had an engineering role; the others all indicated working as a plant chemist. Of the 15 participants who were not employed initially, three indicated that it took less than two years to get a job, two indicated a length of three years (including the participant who did postgraduate studies) and 10 indicated that they still did not work in the industry. Reasons for not working in the industry were: inability to get a job in the field (3); a change in career interest (4); and personal reasons (3) These females indicated having an occupation in one of the following: quality assurance, banking and finance, sales, agriculture and construction, logistics, management, and research.

Not all females employed in the industry stayed. Only 20 of 31 participants who were previously employed in the field were still in the field. Pursuit of postgraduate studies (3), limited upward mobility in the industry (2), change in field (2), migration (2), and preference to work in academia (2) were reasons given for leaving. The females that were still in the industry indicated that they were currently working as one of the following: process engineer, chemical engineer, environmental engineer/specialist, technical officer, project manager, and lean and quality engineer. Countries of employment included Jamaica, Suriname, Canada, and United Arab Emirates.

5) Gender biases in STEM education and employment

This domain required participants to relate their experiences of gender biases as students, engineering job seekers and employees in a STEM field. Only two participants indicated experiencing gender bias in the classroom and on an industrial field trip. Comments made by males suggested that they were "wasting" their time studying engineering because females cannot cope with the rigors of the industrial environment.

Four (4) participants indicated experiencing gender biases at an interview with only two being successful at getting the job. The experiences were based on physical appearance. One participant who provided a response wrote:

> The managing director (male), who is the person that conducted the interview made multiple references to my demeanor and stature in asking questions. He questioned whether or not I would be able to handle and assert myself in difficult interactions with management and line staff.

Ten (10) participants expressed that they experienced some form of gender bias and/or discrimination on the job. Experiences such as being assigned secretarial tasks, ignored in the assignment of engineering tasks, viewed as incompetent and physically weak, and denied promotions were noted. A response received was:

> Delayed promotion to field process engineer, supervisor expressed that I would not be able to handle the "rough" nature of operations team.

One participant included harassment but did not expound on the type(s) of harassment.

6) Perception of choice of engineering discipline

The participants were asked to indicate whether they had regrets of pursuing a career in ChE and to state reason(s). The majority (39) indicated that they had no regrets. Many viewed the discipline as being one that: builds their analytical skills; offers many opportunities for branching out into other fields; and satisfies their desire of having a profession that solves problems and optimizes processes. One participant wrote about the benefit of having a degree in ChE:

> The chemical engineering degree is very diverse. It is a combination of all engineering disciplines. This allows you to better understand operations in the work environment especially if it's a very dynamic one.

One participant who was not working in engineering stated that, in her current employment, she still used principles she learned. Another participant who stated that the degree offered flexibility in applying for various jobs added also that the limited job opportunities in Jamaica made working in the profession a challenge. The two participants who had regrets stated that they were no longer passionate about ChE; one participant still worked in the field.

VI. Discussion

In this study, the enrollment, persistence, and degree quality of females in ChE at UTech, Ja. and their employment success

were examined quantitatively. The study also included a qualitative examination of reasons for females to pursue a career in engineering and the gender-related experiences they faced as students, job seekers and employees of STEM.

Regarding enrollment, an average of 41% of entrants to ChE between 2004 and 2015 were females. This high participation of females in ChE was also reported by Lord, Ohland and Layton [14] for universities in the U.S. Having male family members as role models [10, 25], being good at mathematics and science in high school, and engaging in problem solving [25, 29] were among the list of motivating factors for females to pursue engineering. The influence of teachers was also a factor, indicating that teachers are important recruiters of future engineers [30]. Most females decided to choose engineering as a career option in the latter part of their secondary education. This finding concurred with Madara and Cherotich [25] and indicated that not much exposure to engineering was being provided at the primary education level. As suggested by Maltese and Tai [31], developing an interest in math and science prior to high school might set the tone for students to pursue a STEM career. One way to address this lack of early exposure to STEM would be to have universities participate in STEM promotional campaigns [6]. Based on the overall low enrollment in ChE, several actions are suggested to improve student numbers, including: intensify the promotion of the program through recruitment drives using different forms of mass media; have faculty participate in Career Day, both at primary and high schools; and invite prospective applicants to visit the university for an "open" day to be exposed to the program and its educational activities.

The findings regarding persistence showed that females were graduating at higher rates than males in ChE at UTech, Ja. This achievement was rare in the literature reviewed, with only [11] reporting similar findings for engineering. Specific to ChE, males have been reported [14, 15] to graduate at higher rates. Females were taking less time to complete their degrees because many had a personal drive to complete within the prescribed time. It appeared that intrinsic motivation was more dominant than other types of motivation for females [32]. Having better support structures in place [13] could help females struggling academically to reduce their length of stay in the program and prevent them from leaving. Increasing financial aid to students could also help. Although local ChE students were completing their degree at a higher mean rate (82%) compared with students in undergraduate degrees (60%) in the U.S. [33], the differences between population size and culture at UTech, Ja. and universities in the U.S. has been acknowledged in the study and the limitation that these differences have on the value of the comparison. Extending the study to other engineering disciplines at UTech, Ja. and other universities in the region might provide improved comparisons.

Academically, the results showed that most students received awards in the Second-Class Honors categories, similar to the findings reported by Madara and Namango [19] and the Royal Academy of Engineering [20]. However, females were graduating with more First-Class Honors degrees. Although learning style was not explored in this study and learning preference only mentioned briefly, two interrelated contributors to academic performance were identified: interactions with peers and interaction with lecturers. Relationships with peers and faculty have also been noted as reasons for females to stay in ChE [16]. There is a need for the significance of these two factors on academic performance and retention to be determined through more detailed studies.

The processing industry in Jamaica is small, with limited or no growth in recent times, so it was encouraging to find 59.4% of female graduates in STEM employment with the majority having an engineering role. This percentage was higher than the 20.2% reported for Canada in 2016 [22] and similar to the findings of Rincon, Korn and Williams [26]. While most graduates secured employment shortly after graduation, the profession was losing talents to business and other unrelated fields [23] because of limited employment opportunities. One way to address this loss would be to expose female students to local and foreign STEM entrepreneurs to promote the idea of starting a business in the field. Further study on the role of female engineers' self-efficacy in career persistence is recommended.

While few studies have indicated that gender biases might not be as prevalent as in the past [2, 5, 24], we are still seeing some forms of bias in the school and work environments. The experiences of gender bias appeared to be associated with societal stereotypes which expect females to conform to traditional gender roles [26]. Discrimination, such as being assigned inferior and non-challenging tasks and being overlooked for promotions, were identified. This finding was supported by [21, 27, 34]. Although not many of the participants indicated having encountered these experiences, based on this study, it was not possible to confirm that there has been a decline in gender biases in these environments, as this was outside the scope of the study. Based on the responses received from participants, elements of gender bias still existed in STEM employment in Jamaica. It is necessary to educate both males and females in gender biases and their effects on people from a young age. Universities could participate in this education campaign by undertaking more extensive research on gender issues in Jamaica and sharing the findings with relevant stakeholders. Psychological impacts of gender bias and coping strategies were not examined in this study, but these are areas of interest for future investigations.

The authors declare that they are members of the ChE Department at Utech, Ja. serving either as faculty or staff. All authors are members of the student recruitment and marketing team for the SOE. Based on the relationships between the authors and participants in the study, several measures were taken to reduce research biases, including: a team comprising of members from all engineering programs developed the survey items; the survey link was sent by email to participants using the department's email address; participants were not requested to provide any form of identification; and an independent reviewer was involved throughout the different stages of the study.

VII. Conclusion

This work contributes to the scarce literature on females in engineering education and occupations in Jamaica and the rest of the Caribbean. The study explored females' experiences while pursuing careers in engineering and, while the findings were informative, they do not represent all the experiences of female engineers. However, the findings have contributed to the identification of key areas of concern that need to be addressed both to promote more female participation in STEM and to address gender discrimination.

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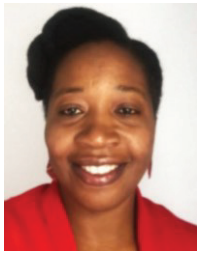

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