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Challenges Faced by Female-Students in Engineering-Education

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Abstract
Gender-related challenges in learning technical courses are universal phenomenon. These challenges could restrain female students from achieving their fullest potential. The main focus of this study, therefore, is to examine self-recognized challenges faced by undergraduate female students in pursuing engineering at the School of Engineering (SOE), Moi University (MU). This article is an account from a larger gender-related study based on SOE, MU. Quantitative and qualitative methods have been applied in this study. The researchers designed, administered and analyzed a 20-question questioner addressed to female undergraduate students at SOE, MU. The focal point (single-school, cross-sectional) sample was chosen at random, and was limited to 50 female pupils representing each of the 5 engineering departments of SOE (about 20% of the population of the female students) at 2014/2015 academic year. From the survey reports, the sample consisted of 45 students (90%) under regular (GSSP) program and 5students (10%) under Privately Sponsored Students Program (PSSP). The respondents included students from each year of a 5-year degree-program: 25 students (50%) in 5th year, 17 students (34%) in 4th year, 3 students (6%) in 3rd year, 3 students (6%) in 2nd year and 2 students (4%) in 1st year of study. The age bracket of female students was between 18 and 26 years old. Qualitative Data Coding Techniques were applied to interpret the collected data. The responses to the questioner were analyzed using NVivo software (version 10: QSR, 2012). 66% of the respondents agreed that there are barriers in their education at SOE. Based on the findings and their analysis, it is apparent, that the female students, indeed, faced numerous gender-related challenges and even harassment from teachers and classmates in studying at SOE. The study has made recommendations: in order to increase Retention and improve learning environment in the field of engineering education, female student Support and Mentoring activities should be designed and incorporated at engineering school.
Keywords: Females, Gender-related challenges, Undergraduate engineering education.

1. Introduction

According to Jackson (2010) engineering and technology are prerequisite for economic and industrial growth and development of any country. Today‘s engineering graduates will have to resolve tomorrow‘s problems in a world that is, as never before, progresses much more rapidly, and facing on its way, new, critical challenges. This situation creates significant demand for engineering education to evolve, in order to, successfully train a diverse taskforce of engineers, to deal with these challenges. Importance of recruiting and retention of engineering students, to keep up with workforce demand and technological advancements, have been highlighted in several publications (Zepke& Leach, 2005; Nerad & Miller, 1996; Yurtseven, 2002; Lau, 2003). Importance of gender-diversity, in engineering profession and engineering education, has also been recognized (see Starovoytova & Cherotich (2016)).

Increasing the number of female-students in engineering-education has always been a colossal undertaking. The main-challenges, as acknowledged by Starovoytova & Cherotich (2016), are based on a remarkable-phenomenon: “when engineering-stereotype and gender-stereotype collide head-to-head”. Engineering-stereotype is whereby engineering perceived as “too hard”, “masculine” and “noisy and dirty” profession, and Gender-stereotype is whereby females perceived as inferior, weak, fragile, very dependant, and less-intellectually-capable, than males, species. Their rightful place, according to the stereotype, should be limited to only two-places in the house: kitchen and … bed-room.

Furthermore, there are also numerous gender-related challenges in learning of technical courses, which additionally contribute to gender underrepresentation in engineering education. As a result, females are driven away from engineering and technology by the content and climate of technical institutions, referred to as an atmosphere of “dominant masculinity” (Livingstone, 2004; Blickenstaff, 2005). The UN Secretary General, in his keynote address at the 5th Global Colloquium of University Presidents at April, 2011 titled *“Empowering Women to change the world: What Universities and UN can Do,”* stated: Women remain second-class-citizens in too-many-countries, deprived of basic-rights or legitimate-opportunities, and he challenged the participants in the Colloquium to help in the fight to overcome discrimination and change perceptions about what women *can* and *should* do.

1.1. Phenomenon of female underrepresentation in engineering education

1.1.1. Global context

Only 9% of the Engineering Profession within the UK is women (Langen& Dekkers, 2005). This low figure is

comparable to that of the USA, where only 11% of Engineers are women (Roberts& Ayre, 2002), but somewhat less than Australia, where 14% of Engineers are women (Bystydzienski& Bird, 2006). Literature on the representation of women in science, technology, math and engineering (STEM) careers has uncovered the presence of a "leaky pipeline," (Seymour, 2002) whereby women systematically drop out of the STEM-track at various points along the education and career ladder. Hence, institutions of higher learning are under tremendous pressure to improve recruitment to keep up with educational competence and better student-outcomes, such as retention and completion (Zepke& Leach, 2005). A number of quantitative (Duderstadt, 2008; Fleming, 2005) and qualitative (Jackson, 2010; Fouad& Singh, 2011; Engineer Your Career, 2009; Bell et. al., 2003) studies have been undertaken aimed at understanding the processes involved in the hesitant approach of women to engineering and at developing measures to change that situation.

1.1.2. Local perspective

The major findings of the recent study by Starovoytova (2016) at the School of Engineering (SOE), Moi University (MU), Kenya for the period between 2003 and 2014, stated that, while MU total admission is steadily increasing, no explicit trend in total enrolment of SOE was established. Analogous, there is no predetermined paten in female admission for both SOE (13.9% average) and MU (45.4% average), however they both skewed in favour of man. The comparison of female admission trends at SOE with other schools of MU revealed that the persistent underrepresentation of females in engineering is perplexing, particularly when female representation in other programs of MU has enjoyed superior improvement over time. Engineering parity ration was found to be 1.68 %, meaning that for every 59 students admitted to MU there was only one student admitted to SOE. Female engineering parity index was found to be 0.0038, meaning that on average for 260 female students admitted to MU only 1(one) female student was admitted to SOE. Total retention rate, SOE was found to be 0.9 (10% drop-outs). The data presented in that paper raise serious questions about the future of Kenya's engineering workforce, as the nation needs extra well-prepared engineers. This gender imbalance presents a missed opportunity; and in order to address the engineering skills shortage systematic intervention into the education system and graduate supply is required.

1.2. Gender-Challenges in engineering education (problem statement and justification of the study)

Gender-related challenges in learning technical courses are universal phenomenon (UNESCO, 2008). For instance, Richard& Susan (2009) observe that female students learning engineering and technology courses receive discouragement and off-putting remarks from their teachers such as: "Females do not become *real* engineers, why should you waste your time?" They further criticize some teachers' inability to provide equal opportunities and participation to both male and female students in learning engineering and technology courses and argue that female students develop "learned helplessness" as a result of the discouragement from the teachers.

Jamieson (2009) states that, some teachers do not provide an environment in which female students can participate equally with male students in learning engineering courses. Kombo (2004) argues that most often teachers treat male students in engineering classes with higher considerations and expectations, while female students are treated with lower expectations and are intimidated. As a result, female students pursuing engineering courses are viewed as incapable. These stereotypes can hinder technological development. Kelly (2000) argues that male students pose challenges to female students in learning engineering and technology courses. They consciously or unconsciously send messages to female students that they are unwelcome in class discussions (Kelly, 2000).

This argument is supported by Gordon (2006) who adds that female students pursuing engineering and technology courses develop low self-esteem and low confidence due to the fact that they are perceived as incompetent. Consequently, they avoid asking or answering questions, for fear of being put down by their teachers and male students, who dominate classes. Klein (2007) further observes that female students fear handling equipment and machines during class projects and laboratory practices due to the fear instilled in them by their teachers and classmates that they are incapable.

The challenges faced by female students from teachers and classmates could probably result in lowered performance. According to Fleming (2005) engineering classroom environment is full of challenges, such as: female students, being very few, feel isolated, they also experienced jokes/remarks made about being a female in engineering or sexual comments from male peers; they also being afraid to ask questions for fear of being ridiculed; not been taken seriously by lecturers and feeling the need to prove oneself by working extra hard to attain the same respect as the male counterparts; not standing up for yourself because it is you against the 'rest of them'. Overall classroom can be a very competitive and at times hash environment. Loshbaugh (2007) observes that gender-related challenges faced by female students in learning technical courses could inhibit them from achieving their fullest potential.

According to Horby (2009) one of the most prominent gender-challenges in engineering education is inequalities in 'power' relations between men and women, with women generally viewing the Profession as

being manifest by a patriarchal bias. For example, Trow's landmark work (1973) stated that when a group is underrepresented in a system, then that system is elitist. In this case, the elite group has been, and continues to be, male; thus, females might feel "out of place", "Women reported struggling for acceptance because they often perceived fewer opportunities to interact with other engineering students or professors" (e.g., help-seeking and peer learning). Further, women reported feeling the need to work harder under more pressure (i.e., effort) to achieve the same end-result as male engineering students. Studies in the United States show also evidence of a "chilly climate" in engineering colleges, whereby female engineers experience isolation, psychological intimidation and loss of confidence that leads to high female dropout rates during college (Atman, 2010).

Several studies indicate that female students face *extra* challenges in learning engineering and technology courses. The challenges are very many and it is not, actually, possible to mention each one of them in this concise study. In this regard, the following summary on challenges is, by no means, exhaustive: Self-Perception of Ability (Girls consider themselves lower than boys with same mathematical ability) (Correll, 2001); in Math and Science Abilities (Loss of self-confidence in these subjects was found to be correlated with drop-outs and uncorrelated with performance)(Brainard, 1998); Isolation (Reports of female isolation increased substantially during the 4-year degree program (Brainard, 1998); Intellectual Intimidation: Behavior of Males in Group Environments (perpetuated by stereotypes. Women report male comments of inappropriate jokes, make them feel unwelcome, devalue them) (Seymour 1995); Overall Confidence (Lack of self-confidence increases throughout university years). These trends are associated with other environmental factors related to institutional setting (Brainard 1998; Hill, 2010). Numerous studies in the U.S. cite trends of females in engineering programs reporting feelings of isolation or psychological alienation due to a male-dominant environment where male students were often hostile toward female students (GAO, 2004). According to Schaefer (2006) some of the challenges established facing female students in learning the engineering courses were ridiculing, intimidation, labeling, teasing and belittling. These challenges could impact negatively on participation, performance, and gender disparities in productivity and employment opportunities.

While a growing body of literature surrounding the "leaky pipeline" and gender-challenges in engineering education exists internationally, very little (if at all) research to date has investigated trends for female engineers in Kenya, principally at university level.

The focus upon women at the undergraduate level, in particular, is critical to understanding and improving gender equity in science and engineering. The undergraduate level of education is acknowledged to be the ''latest point'' for a standard entry into science and engineering fields (Xie &Shauman, 2003).

The realization that female students face more challenges in learning technical courses prompted this study to ascertain gender-related challenges faced by students in learning engineering degree-courses. Research on the student experience is a fundamental kind of research for informing the evolution of engineering education. A broad understanding of the engineering student-experience involves thinking about pathways, navigation, and decision points—how students choose engineering programs, navigate through their programs, and then move on to jobs and careers. Further, looking at students 'experiences broadly entails not just thinking about their learning (*i.e.*, skill and knowledge development in both technical and professional areas) but also their motivation, their identification with engineering, their confidence, and their choices after graduation.

The main focus of this study, therefore, is to examine self-recognized challenges faced by undergraduate female students in pursuing engineering at the SOE, MU.

This research is important to uncovering the ways in which the development of capable female-talent for the growing engineering and technology sector in Kenya can be better accessed. Evaluating challenges of female students and integrating improvement in recruitment efforts will definitely help the institutions of higher learning. Finally, by advancing the understanding of females, of engineering, and of organizational environments of higher education, this study has the potential to enhance strategic policy-making to improve the condition of females in these fields.

2. Materials and methods

This article is an account from a larger gender-related study based on SOE, MU. Quantitative and qualitative methods have been applied in this study. The qualitative part for the study also was used as a basis for the quantitative instrument (the questionnaire). Document analysis, another secondary method of data collection, was a necessary aspect of the study. The methods chosen are unique to this particular study. Researchers in qualitative studies look for patterns, themes, and categories for use in other settings, but do not focus on replication.

In-depth study of the phenomena (the gender-related challenges in engineering education) was conducted, where secondary sources of reputable information were critically reviewed.

In this article, however, the main focus is on the quantitative analysis of data (the questionnaire). The researchers designed, administered and analysed a 20-question questioner addressed to female students at SOE, MU. The questions were based on the review of existing literature and researchers' interest, and in particular

were aimed to collect the information from female pupils about their educational background and how this motivates them to choose engineering; furthermore it investigates their learning experiences in a male-dominated faculty with an aim of identifying key issues that need to be addressed in order to improve the learning environment of female students, and to attract more female students to engineering. In addition the study determined the future career aspirations of the female students.

The focal point (single-school, cross-sectional) sample was chosen at random, and was limited to 50 female pupils (about 20% of the population of the female students) at 2014/2015 academic year. Qualitative Data Coding Techniques were applied to interpret the collected data. The responses to the questioner were analyzed using NVivo software (version 10: QSR, 2012). The survey on demographic information was used strictly for statistical purposes, such as averages of age among other information. All participants were to read an introductory paragraph of the questioner, which guaranteed that their names would not be mentioned anywhere in the study.

By acquiring information directly from the female students, some of whom might be experiencing challenges in their education , the authors anticipated to discover exactly what the barriers are, why they are still so prevalent, and how they can be broken down.

2.1. Relevant to the study background information on MU and SOE.

The study was conducted at the SOE, MU, Eldoret, Kenya. MU is the second public university to be established in Kenya, after the University of Nairobi. It was set up by the Moi University Act of 1984 after recommendations from the Mackay Commission. It started off with one school with 20 students. In the spirit of" widening access to higher education", as of 2007 it had over 20,000 students whom 17,086 were undergraduates, and operates eight campuses and the two constituent colleges. SOE was founded in 1986 as one of the pioneer school of MU and currently offering six undergraduate and four postgraduate engineering programs. All the engineering programs have Integrated Privately-Sponsored Student Programs (PSSP) with the Government Sponsored Students Programs (GSSP). The subject of this study is female undergraduate students at SOE, MU. SOE currently has 5 engineering departments, namely: CPE-Chemical& Process Engineering, CVS-Civil& Structural Engineering, MPE-Mechanical& Production Engineering, MIT-Manufacturing, Industrial& Textile Engineering, and ECE-Electrical& Communication Engineering (MU official website, 2015).

2.2. Sample size and composition

At the 2014/2015 academic year, population of female students in the SOE was 236; a sample size of 50 students was taken at random from each department (approximately 20% of the total number of female students). Table 1 shows the number of female students per department that formed the subject sample.

Table1: Number of students in survey group

Department	Total Number of female students	Number of female students in the survey group
CPE	63	13
CVS	55	11
MPE	22	5
MIT	20	4
ECE	83	17
Total	**236**	**50**

From the survey reports, the sample consisted of 45 students (90%) under regular Government Sponsored Students Program (GSSP) and 5students (10%) under Privately Sponsored Students Program (PSSP). The respondents included students from each year of a 5-year degree-program: 25 students (50%) in 5th year, 17 students (34%) in 4th year, 3 students (6%) in 3rd year, 3 students (6%) in 2nd year and 2 students (4%) in 1st year. The age bracket of female students was between 18 and 26 years old.

3. Results

Every one of 50 surveyed-questioners was returned to the researches after completion (giving 100% response-rate). While general response-rate for most questions was 100%, few questions proven to give various complications probably due interpretation and lack of comprehension and therefore these particular questions were left blank. The questions and corresponding responses (%) are: Q3-90; Q13-98; Q14-92; and Q16-84. Due to the large number of questions, for ease of reference, and, in addition, to avoid repetitions and disorientation, the results, in this section, are followed directly by their analysis. The questioner was evaluated question by question. Questions appear exactly the way they are stated in the original questioner.

Q1. Indicate your parental (both your father's and your mother's) education level

Table 2 shows the summary of the responses.

Table 2: Parents level of education

Level of education	Father's level of education		Mother's level of education	
	Frequency	Percentage	Frequency	Percentage
Primary	2	4%	2	4%
Secondary	7	14%	16	32%
Tertiary	12	24%	18	36%
University	20	40%	9	18%
No answer	7	14%	5	10%

For the case of fathers' level of education, it showed that the highest number, (40%) were university graduates, while 24% completed tertiary education. For the mothers, tertiary was the highest (36%), closely followed (32%) by secondary level of education. Overall tertiary level of education was prevalent, giving a highest total for fathers and mothers (60%), very closely followed by university level of education of 58%.

Surprisingly, 24% of the respondents did not provide any answer to this question. Children usually very proud of the achievements of their parents, logically, in this case the authors hypothesize that the parents of these students might have not reached even primary level of education.

Q2. *What is your parents' occupation?*

Table 3 shows the summary of the responses.

Table 3: Current parents' occupation

Occupation	M %	F %	Total %	Occupation	M %	F %	Total %
Engineering related	6	8	14	Agricultural (other than farming)	12	4	16
Farming	26	10	36	Administration	2	4	6
Teaching	4	22	26	Civil servant	2	2	4
Business	4	12	16	Blaster	2	2	4
Retired	2	4	6	Catering	18	2	20
Office work	4	2	6	No answer	-	20	20
Account/banking	18	8	26	**Total**	**100**	**100**	

Key: M-mother; F-father

Out of the total students who responded to the question, only 4 students (8%) had their fathers employed in engineering related field, while 3students(6%) had their mothers employed in engineering or related field. It was expected that most female in engineering pursued engineering because their parents are in such engineering and related fields.

The rest of the students had their parents employed in non-engineering related fields. For fathers' occupation, the highest number, 11 students (22%) having their fathers in teaching and related fields and the second highest number 6 students (15%) had their fathers in business and related fields. For mothers' occupation, out of the total who responded, 41 (82%) students, to the question we had the highest number, 13 students (31.70%) having their mothers in teaching and related field and the second highest number, 9 students (21.95%) had their mothers in business and related field. Overall, the farming was prevailing, giving a total of 36%, followed by teaching and banking, each with 26%. Again, large fraction of students did not provide any answer for their mothers' occupation, and again, the authors could theorize that the mothers were just staying at home-housewives.

Hence from survey reports, we can conclude that parents being in other occupation, especially teaching and related fields and business and related fields somehow had influence on female students pursuing engineering, hence such influence and factors should be look into.

Q3. What is your parents' place of residence (rural or urban)?

24 students (53.33%) had their parents residing in rural and 21 students (46.67%) had their parents residing in urban area. This is a clear indication that place of residents of the parents does not influence in any way career choice of the female students to pursue engineering.

Q 4: Indicate how many siblings are in your family.
Table 4 shows the summary of the responses.

Table 4: Sibling in the family

Number of siblings	Frequency	Percentage	Valid percentage
0	1	2%	2.17%
1	2	4%	4.35%
2	3	6%	6.52%
3	11	22%	23.91%
4	10	20%	21.73%
5	6	12%	13.04%
6	6	12%	13.04%
7	2	4%	4.35%
8	2	4%	4.35%
9	2	4%	4.35%
12	1	2%	2.17%
No answer	4	4%	-
Total	50	100%	100%

Concerning the number of siblings where all the respondents come from families with 0-12 siblings, it shows that the number of the siblings in a family somehow influenced one choice to pursue engineering, where those with siblings between 3-6 had the highest number of female students (64%) pursue engineering, while as he number of siblings increases beyond 6 the number of those female students who pursued engineering decreases and also as the number of siblings goes below 3 the number of female students who pursue engineering decreases. The highest number (22%) of respondents came from the family of 3 siblings, closely followed by 20% of the students coming from the family with 4 siblings.

Q5. Why did you enter engineering as profession? How did it become an interest for you?
21 students (42%) link their choice to be in engineering to passion, interest and the love for engineering. The survey shows that it become of interest to them because the long to carry out all that entails to engineering for example coming up with technical solutions to the problems and challenges they come across in their real life situation. 10 students (20%) said they enter to engineering because of their good performance in mathematics, physics and chemistry at high school which made them suitable to pursue engineering and formed a strong foundation for them to pursue engineering. This shows that perception of students towards science and mathematics while at high school had great impact when it comes to pursuing engineering. 15 students (30%) said their entry to engineering was through the motivation, guidance and inspirations they received from different people for example role-models, parents, relatives, successful engineers in the field already, other siblings, motivational speakers they came across while in high school and inspiration they received while in high school from their former students who had gone before them and become successful in engineering. The study concludes that motivating people to pursue engineering plays a critical role especially to those who lack confidence to pursue engineering or those who have not made up their minds on the fields to pursue.

3 students (6%) considered joining engineering because, the course according to them looked prestigious and they wanted to earn the title of being an Engineer. One of these students said:"When you tell your parents and relatives that you are planning to study engineering, they, as you would expect, smile with pride and happiness-in their eyes engineering is really a prestigious profession. Your friends also, all of a sudden, put you in a higher intellectual category than before. People you have just met start asking you questions about engineering or asking to help them with some mathematical calculations or ask you to fix their laptop or a mobile phone…"

3 students (6%) said they had to pursue engineering because it was their dream-career. While 2 students (4%) joined engineering because they had no option of taking any other courses. 2 students (4%) said that they choose engineering as their second option after missing chances to pursue their dreams-careers of medicine.

Q 6: Do you find engineering both interesting and comfortable to you? If not, explain why.
42 respondents (84%) said that engineering is both comfortable and interesting, while 8 students (16%) found engineering not comfortable or interesting.

The main issues cited by the female participants that made them uncomfortable in classes included the engineering coursework is time-consuming and laborious, in addition the engineering in the university is more theoretical rather than the practical experience, they ever longed for.

Q7: Do you like being in engineering field? What do you like most or least about being involved in engineering?
From the report on the survey out of the total respondents, 42 students (84%) like being in engineering and 8 students (16%) don't like being in engineering, some of the likes from the focus group included, the ability to think critically when it comes to getting technical solution to some problems, involvement in a project from start

to finish provides satisfaction; they like having an impact; it is challenging; there are many interesting and diverse problems to solve which often require creative thinking; financial benefits provide a sense of success, comfort and reasonable living and certain amount of respect, the dynamic nature of the field due to technological advancements each and every day, and many pinpointed the exciting part of the practical work and fieldwork, especially during Industrial attachment, which is compulsory 12 weeks exercise for 3rd and 4th year students in SOE, MU. They pointed that when one is in engineering field one tends to receive respect from people as one is termed to be tough and clever. Those who dislike the field, gave some dislikes concerning engineering, for example some say it is a dirty field since it entails working with hands, some dislike the perception people have for female in engineering now that he field is perceived as a male field and others do not like the toughness and complexity of engineering profession.

Q 8: Do you think curriculum for engineering courses favor both genders equally? If no, explain areas where you feel curriculum does not favor equally?

All the participants reported that the curriculum that was being used favored both genders equally. We can conclude that particular curriculum does not have any direct effect on the number of female found in SOE.

Q 9: Do you think females are treated differently in engineering education? Yes by whom?

36 students (72%) disagree that females are treated differently in engineering education and 14 students (28%) respondents agreed that they were treated differently.

Out of those who agreed that female where being treated differently, 3 students (6%) said they were being treated differently by their fellow male-counterparts who mostly consider them as the weaker objects when it comes to engineering. 6 students (12%) responded that the lectures treated them differently either positively or negatively, some lectures kept on encouraging females, being the rare species, to work hard, on the other hand some lectures discourages female students and at times even make sexist comments which make ladies feel that their dignity is lowered. In addition, female students said, that most of the times they being referred to as Miss "so &so", whereas the male students are typically referred to on a first name basis. 2 students (4%) respondents said technicians in the laboratories treat female differently during practical lessons where some time females were being exempted from some work just on the fact that they are female and they do not have capability to handle some of the practical work, or even worse that they can spoil equipment. Three students (6%) said that some lecturers and technicians tried to suggest to them (masqueraded as a joke) an exchange of increased marks for a sexual favor. Although this had never materialized, the mere fact of this kind of offensive suggestions left some shocking memories and disgust (as affected students revealed).

Q 10: Do you think the field of engineering is a field for both male and female students? Why or why not?

From the survey report all participants, 50 students (100%) students, confirmed that engineering field was meant for both male and females. They pointed out on some strong opinions that both genders: had equal capability, were being subjected to the same curriculum, received equal basic education, both are equally tough and important and also they said no specific career was designated for any gender. Subject to this report, in the opinion of all respondents, engineering is a field is to be considered appropriate for both genders: males and females.

Q11: Do you think female in engineering perform equally well as the male counterparts pursuing the same engineering courses?

From the report of the survey, 46 students (92%) agreed that female perform equally as well as their male counterparts. 4 students (8%), however, believe that female don't perform equally as their male counterparts. Although, this is just a small percentage, nevertheless, the reasons behind this believe should be investigated further.

Q 12: Do you think male and female students treat each other respectfully in engineering education classes?

42 students (84%) of the respondents agree that female is treated respectfully while eight students (16%) respondents said female are not treated respectfully. Some who disagreed that women are treated with respect said at times the female themselves are the cause of the disrespect they are facing. Some ladies carry themselves in such a manner that that they do not deserve respect from anyone ranging from their fellow female- to their male- counterparts (example indicated as some females exposing their assets in rather revealing outfits in the classroom environment, which can cause some diversion of attention from the lecturer to them; also male students and even lecturers can get an erroneous perception of the ladies morals, leading to disrespectful signs and remarks).

Q 13: Do you think engineering lectures treat male and female students equally and fairly? If no, why do you think so?

The way lectures treat the female students at class environment can have a negative impact of female engineering students not only when it comes to performance but also losing interest to continue pursuing the course. 43 students (87.76%) agrees that both male and female are treated fairly and equally by the lectures, while 7 students (14.29%) have a strong feeling that female and male are not treated equally either in a positive way or negative, as some of the lecturers treat female engineering students as weaker beings in the field others

encourage the female students to work extra hard for they are advantageous to be in male-dominated field. Out of those who felt that female treated differently, 2 students (28.57%) of the respondents said that male lectures tend to be a threat to female students as they ask for sexual favors in exchange to good grades, if one fails to offer the favor then the male lecturers tend to manipulate their grades to ensure that they fail their course.

Q14. Do you usually choose males or females to be in your groups when you are doing group projects in technology education classes? Why and why not?

Out of the total who responded to the question, 37 students (80.43%) students responded that they include both gender in their groups. They said that both gender is a good mix when it comes contribution of ideas, since all of them are subjected to the same curriculum then either genders can fit comfortably to the groups as long as one is committed to working and they also had a strong opinion that working with either gender was comfortable to them.

Out of the total who responded to the question, 7 students (15.22%) of the respondents said that they prefer only male counterparts in a class project group, this is because they say male are brighter than female. Male have better understanding when it comes to technical aspect of the course, male are hardworking and this group of respondents also pointed out that a class group with more than one female tends to divert the agenda of the group project to talking of social life issues.

Out of the total students who responded, 2 students (4.35%) are for the opinion that they can choose only female students to their class project groups because they feel comfortable working with close female friends, also that it is easier and convenient to work with same gender when it comes to group project.

Q 15: Do you think there are specific barriers that keep females and women from pursuing careers in engineering? If yes, what are some of the barriers?

33 students (66%) agreed that there are barriers, whereas 17 students (34%) feel there are no barriers that keep the female from pursuing engineering. Some of the major barriers that were pinpointed by the respondents include: Stereotypes that exists that engineering is a male and hard profession; Societal expectation, family backgrounds and cultures; Lack of motivation from society and people around; Mathematics and science are hard for most females; Roles that female play in a society restricts them to do technical course which are always demanding; Cut-off marks to join engineering are too high and it therefore discourage off many from joining engineering courses; Lack of self-confidence amongst most females to pursue engineering; and that in male-dominated field female are being looked down on.

Q 16: Rank the following factors that lead to female drop out from engineering careers here at university, number 1-6

Table 5 shows the summary of the responses.

Table5: Perceived factors for female drop out from engineering careers in the university

Rank / Factor	1	2	3	4	5	6
Discontinuation on academic grounds	20	9	7	7	0	1
Discontinuation on other grounds	2	11	5	11	11	1
Lack of interest	10	9	8	12	2	1
Lack of confidence to continue with program	8	9	11	8	8	0
Long duration of program	1	4	7	6	21	3
Other reasons	1	0	4	0	0	-
No answer	8	8	8	8	8	8

From the survey of perception of female students on the dropout phenomenon at SOE, discontinuation on academic ground is indicated to be the main reason (40%), followed by lack of interest (20%) and lack of confidence (16%). A substantial fraction of female students (16%) did not provide any answer. It can be viewed as a fear of even discussing the subject of dropouts.

Q 17: Do you intend to continue pursing your career in the path of engineering even after your undergraduate degree? If not, why?

Out of the total respondents, 46 students (92%) said they would continue pursuing the career in path of engineering. This means that a great percentage of female those who have had a small experience in engineering are not ready to leave the path. Only 4 students (8%) respondents said they were not going to continue to pursue career in path of engineering, some of the reasons for this decision is that they are not comfortable with the terms of engineering job, engineering was not their passion (at the first place) so pursuing it further will be difficult, another reason was given is disappointment with engineering (as reality was below their expectations) and also the feeling that pursuing the career further than undergraduate is more complicated and also very expensive.

Q 18: In your opinion, what do you think must be done in order to encourage more women to pursue courses in engineering?

From the reports on this question the respondents gave a strong opinion on the way to encourage more female to pursue engineering. Below is a summary of opinion from the survey group: Demystifying the notion that engineering is for men and female cannot perform well in the fields through seminars, conferences and workshops; Mobilization of women to do engineering as well as giving a free waiver to all women willing to do engineering; Creating awareness amongst high school girls by involving them in forum that encouraged them to join engineering as a career; Encouraging and advice girls at high school to take all the sciences and mathematics which in turn will prepare them in pursuing engineering at the university; More mentorship to be provided not only to those who want to join but also those already in the field of engineering; Creating a more active science group and clubs at high school to enhance familiarity with science and hence prepare students to pursue engineering and related careers; and Creating awareness among female on the opportunities available after the pursue engineering this will encourage more to join because of clear future among others.

Q 19: What are your immediate plans after graduation?

From the report on the survey, respondents had various plans after graduation. In this question some responded did not only give the most immediate plans but also the concurrent sequence activities of what they want to do after graduation. The numbers and percentage indicate the most immediate plans after graduation: 18 students (36%) want to pursue masters after graduation, out of the respondents prefer getting into job immediately, 6 students (12%) said they want to get to engineering or technical field, even through volunteering, so as to acquire relevant skills and hence to fulfill the requirements for registration as Professional Engineer; 3 students (6%) said that they want to be in internship so as to acquire practical skills of engineering; 2 students (4%) wanted to venture into business and entrepreneurship. From the report, it is clear, that despite the varied plans female in engineering have after graduation, many are ready and willing to continue pursuing engineering in one way or the other.12% of the students have not decided yet (at the time of the study) what they will do after graduation.

Q 20: What would be your honest recommendations to the current form 4 secondary school female candidates (with regard to Engineering education and engineering profession)?

Recommendations from the survey reports gave mixed opinions, the majority recommended that pursuing engineering is a good decision one can make, some though encouraged them to do engineering, said that unless one has real passion for it and interest then they should consider to pursue other careers. They recommended that pursing the career calls for one's positive attitude towards the career and dedication when pursuing it since it is involving hard work and real continual dedication. 16%, however, had very negative recommendations that engineering is difficult and they should not consider pursuing it, adding that engineering is meant for only the tough males and "iron ladies". Iron lady or 'masculine woman' is described as a 'monster' with gender problems and a risk to assumed stable identities, social roles and positions in the hierarchy of professions. The fear of losing femininity therefore becomes widespread and real (Ernest, 2003).

Some even said that, apparently, it was their mistake to join engineering school and they wish they could turn back time to choose better (in their eyes) profession. Some also complained that 'Engineering is the most difficult profession offered on campus'.

4. Discussions and recommendations.

8% of the female students' fathers and 6% of the students' mothers were in engineering-related fields/occupations. A few students, who had a mother engineer admitted that the presence of the female engineer made them decide to take up engineering. The female engineers within the family in this case served as role-models for the girls. Previous research has shown that the presence of a role-model or lack of; is one of the main reasons that will influence female students to take engineering or in their absence influence them not to choose engineering (Leonard, 2005). Same sex role-models, from past research, showing that the tendency to feel good about oneself due to a fellow in-group member's success occurs primarily among minority rather than majority group members (Brewer & Weber, 1994). Also, the impact of seeing same-sex experts is likely to be stronger for individuals who subjectively identify with these experts, which is consistent with Markus & Nurius's (1986) early research on the *possible self* (i.e., one's mental representation of what one could become in the future). This prediction is also compatible with existing research on role models suggesting that perceiving successful others as inspirational is contingent on seeing the other person's success as relevant to one's own interest and believing that it is personally attainable (Lockwood & Kunda, 1997, 1999). The unique benefit of same-sex role models simultaneously allows women to develop an successful sense of self in STEM while embracing their gender identity. Put simply, exposure to positive female role models allows women to flourish in STEM without feeling bad about their gender.

20% of students revealed they enter into engineering because of their good performance in mathematics, physics and chemistry at high school. A good number of these students did not even think about doing engineering until after high school when they obtained their Kenya certificate of Secondary Education Examination (KCSE) results. As a prerequisite, engineering courses require high scores in mathematics and science and these girls are able to meet this easily. Similar studies have shown that excellence in mathematics

and physics is one of the most fundamental reasons why females choose engineering (Bell, 2003; Cronin &Roger, 1999).

Numerous factors influencing the choice of an engineering career have been recognized. For example: *Psychological* (studying engineering for its own sake, to experience enjoyment that is inherent in the activity, *e.g.*," I believe engineering is amusing", "I feel much energized when I am doing engineering". This factor was based on the work of Guay et al. (2000); *Behavioral* (motivation related to practical and hands-on aspects of engineering, *e.g.*, "I like to figure out how things work", "I like to build stuff". This factor was developed by the APPLES research team to capture the hands-on, action orientation of engineering)(Donaldson, 2008); *Social Good* (belief that engineers improve the welfare of society, *e.g.*, "Engineers have contributed greatly to fixing problems in the world", "Technology and engineering indeed plays an important role in solving society's problems". This factor was borrowed from the Pittsburgh Freshman Engineering Attitudes survey (Besterfield - Sacre et al. 1995, 1997, 2001); *Financial* (belief that engineering is a financially rewarding career, *e.g.*, "Engineers are well paid", "An engineering degree will assure me of a job when I graduate". This factor was also borrowed from the Pittsburgh Freshman Engineering Attitudes survey (Besterfield-Sacre et al. 1995, 1997, 2001); *Mentor Influence* (influence of university and non-university affiliated mentors, *e.g.*, "A faculty member, academic advisor, teaching assistant or other university affiliated person has encouraged and/or inspired me to study engineering ","A mentor has introduced me to people and opportunities in engineering". This factor was developed based on the work of Hanson (1996); and *Parental Influence* (parental influences to study engineering, *e.g.*, "My parents want me to be an engineer". This factor was borrowed from the Pittsburgh Freshman Engineering Attitudes survey (Besterfield-Sacre et al. 1995, 1997, 2001).

That was conjectural preamble; now back to our study, where 42% of females link their choice to be in engineering to passion, interest and the love for engineering, while 6% said they had to pursue engineering because it was their dream-career since their childhood. This segment of students is very self-motivated to face any challenges on their education path, as they are looking and focusing on the end result-on their dream. There is nothing worse than having to wake up every morning to robotically go to work you do not even care about. However, this is never an issue when one is passionate about their work. If you are not forced to work somewhere because of money, and you truly enjoy what you do, you can even do it for free, you can go beyond the call of duty, and you are actually unstoppable, full of energy and excellent ideas. That kind of students probably also have a bigger chance to succeed in the career, which they love. Our working careers will consume most of our lives, so we might as well do something that we love.

30% of the students said their entry to engineering was through the motivation, guidance and inspirations they received from different people for example role models, parents, relatives, successful engineers in the field already, and others. For some, parental motivation was tied to family pride:" I am a first-generation university student, and because this [engineering] is a really hard major, graduating is one thing, it would really be a very big accomplishment for me and for my family" (Kilgore et al., 2009).

Motivation is an important factor in looking at the educational pathways of undergraduate engineering students. As one theory suggests, people act based on their motivation to fulfill basic human needs for autonomy, competence, and relatedness (Lawler, 2006). Similar research studies have shown that influence from parents, and career advisers are also one of the reasons that girls choose engineering (Seymour et. al., 2005). These people have the power to influence the girls' career choice because they are able to recognize the special talents in their science subjects and push them towards a career where they can utilize their special talents.

6% of the respondents considered joining engineering because the course according to them looked prestigious. 4% joined engineering because they had no option of taking any other courses, while 4% choose engineering as their second option after missing chances to pursue their dreams-careers of medicine. Well, being a second choice is always disappointing; however, in comparison with medicine it is understandable and justifiable, as medicine is a very strong and mature opponent for engineering. Medicine is inherently considered as highly respectable, prestigious "care-giving" profession. Engineering, however, although being somewhat prestigious cannot be directly associated with care providing, and according to Starovoytova (2016) engineering, still, has a huge image problem.

Students are motivated to study engineering by a variety of factors, such as psychological/personal reasons, a desire to contribute to the social good, financial security, or, in some cases, seeing engineering as a stepping stone to another profession. Some factors are strong among all engineering students—for example, intrinsic psychological and behavioral motivation. The above narratives, however, do not gauge the intensity or frequency of the encouragement. Similarly, the reasons for the encouragement were not probed.

15.22% of the respondents preferred only male counterparts in a class project group (reason being, that, by their perception, males are apparently brighter than females!).

4.35 % of the female students preferred only female students to form their class project team because they feel comfortable working with close friends. This illustrates two extremes of the team's composition, as preferably for diversity of talent pool, the team should be representative of both genders. Most of the time,

however, students do not understand fully the importance of team-work for their future career. For instance; students may not anticipate how the team-work skills they develop in courses using project-based learning are applied when working as an intern on, for example, at internationally-distributed design team. Team-work, apparently, is an essential part of engineering practice, as many times you can be put in such circumstances where you should work and collaborate closely with other experts, some of whom you might not necessarily know or even like. Simply put, in real time situation, engineers do not have that luxury to choose their team-members.

6% of the respondents said they were being treated differently by their fellow male-counterparts, who mostly consider them as weaker objects, when it comes to engineering. 12% of respondents said that the lectures treated them differently either positively or negatively. 4% of students said technicians in the laboratories treat female differently during practical lesson. This is compatible with previous researches: 'Having one's ideas ignored (during lab sessions) by the other students in their group, only to have another male in the group repeat the idea and see 'everyone jump on it' (Marshall, 1997). If women are in an environment in which they perceive differential treatment, but their male counterparts do not, it can sometimes serve to increase the gender divide between the males and females. For example, females may be reluctant to express their concerns about differential treatment from men because of the likelihood that their perspective will be disregarded (Reuters, 2010).

16% of the female students said they were not treated respectfully by the males in a class; also sometimes they experienced a "sexual pressure" from their male classmates. Previous researches also mention similar situations, for example: 'Being conscious of male counterparts 'checking them out all the time'. Having to carefully choose the clothes one wears when making presentations. Wearing a skirt or dress, and being subjected to comments such as 'trying to gain extra marks by showing off a bit of a leg…' (Schemerhorn, 2001).

14.29% of the respondents had a strong feeling that female and male are not treated equally either in a positive way or negative by their lectures. They reported that teachers often ignored and paid less attention to female students compared to male students during class discussions and activities. From the findings, female students received less feedback and their comments, opinions and ideas were given less credit. In addition, two of the female students argued that teachers received more positively questions from male students and tended to ask male students questions that call for "higher order" critical thinking whereas female students were asked "lower order" or even primitive and basic facts. It follows that some teachers had higher expectations of male students and thus encouraged them, leaving the females discouraged and this may have made the females feel ridiculed, out of place and left out. This is in agreement with similar studies of CLTNet (2005).

About 48% of the female students had post-graduation plans focused exclusively on engineering (work and/or graduate school). These students were strongly motivated to study engineering for intrinsic psychological reasons and were likely to have had extensive internship experiences. Psychological motivation (motivation to study engineering for its own sake and for the enjoyment of it) and confidence in professional and interpersonal skills (self-rated ability in leadership, communication, teamwork, business ability, social self-confidence, *etc.*) were significant predictors of students' post-graduation plans. Most other students conceived of their careers as combining engineering and non-engineering components. While only 12% of the were unsure about their plans to enter into engineering work, approximately one-quarter were unsure about their plans related to a non-engineering job or graduate school (either engineering or non-engineering). In other words, one in four female students was considering how non-engineering options might fit into their future. This is perhaps to be expected of students who were entering a period of exploration that frequently occurs between adolescence and adulthood. This study reinforce that many students do not think of their future in terms of a single job or even one career, but rather as one that consists of many possibilities and includes non-engineering activities. This is in accord with Lichtenstein et al. (2009) stating that: "…Participants felt that their engineering education and the problem-solving skills they had learned would provide a good basis for exploring different options after graduation"

Few students proposed the way to encourage more female to pursue engineering as to giving a free waiver to all women willing to do engineering. Critics argue that this Affirmative Action approach dilutes standards and also suggests that women are an intellectually weaker gender. Some argue against affirmative action on the basis that women do not need positive-discrimination because they are capable.

11% of the female students that participated in this research confirmed that they had experienced some form of gender harassment (despite the fact that they did not express it in the exact same words) at one time or the other, within the SOE, MU. Gender harassment within the school was seen through two main dynamics; through group socialization of the male students and through the special treatment that the female students *sometimes* received from the lecturers and lab technicians. To begin this central part of our discussion, first we have to define gender harassment, and according to Chaika (1999), it is *"... a range of exclusion, marginalizing, and resistance behaviors (usually exhibited by men)which result in women being discouraged or inhibited from access to and progression in SET (Science engineering and technology) education, training and employment. These behaviors' are often subtle and sometimes unintentional. Nevertheless, they continue to have a significant*

impact on the way women perceive SET and careers and education in these fields."

Every member of an academic community should know about the laws and policies that pertain to discrimination and harassment. This offence is addressed, at a national level, in Section 21 of the Public Officers Ethics Act (2003), Employment Act (2008) and is criminalized in Section 23 of the Sexual Offences Act (2006). To address this need at institutional level, in MU, for example, IGERD (Institute for Gender Equity, Research and Development) in 2012 has developed Sexual Harassment and Discrimination Policy. The Policy provides for the establishment of the three main components: (1) an effective sexual discrimination and harassment prevention and complaints mechanism; (2) an investigative and monitoring process; and (3) a record-keeping system.

Knowing and understanding the definition of sexual harassment and the university's SH policy is paramount. This knowledge helps to deal with a situation if, for example, you are approached for help by someone who feels harassed, or if you are harassed or accused of harassment, or even if you become romantically/sexually involved with a colleague or someone you teach/supervise. Understanding the nature of discrimination and harassment helps to avoid making unlawful mistakes and to recognize mistakes made by others. However, from several private responses, people complain that generally they are not sure on which offices/individuals at the university deal with harassment and discrimination complaints and offer education about university policies and procedures. Another issue of concern was reporting procedure, in particular, lack of alternatives for reporting their concerns, in case they do not feel comfortable talking personally about an incident.

The study, therefore, has made two key recommendations:

To increase Retention and improve learning environment in the field of engineering education through female student Support and Mentoring, and in particular:

1. To provide unified student support services, including mentoring, tutoring and advocacy. To establish a mentoring program within the faculty where senior female engineering students could mentor junior female engineering students to nurture the progression of the younger engineering students and lower their dropout rates. Mentoring appears to be a strategy that also helps increase women's confidence in their abilities (MentorNet, 2002). MentorNet (www.MentorNet.net), *the e-mentoring network for women in engineering and science*, is a nonprofit organization. MentorNet is an excellent resource; its mission is to further women's progress in scientific and technical fields through a dynamic, technology-supported mentoring program and to advance women and society by developing a diversified, expanded, and talented workforce. The vision is threefold: to establish excellence in large-scale e-mentoring, to create the e-community of choice for women in engineering and science through online mentoring and networking, and to leverage that community for positive social change.
2. When one sees discrimination, harassment, or unsafe working conditions, they need to speak out against them openly and with no fear of victimization or being ridiculed, and also support others who speak out. Awareness campaign should be conducted at MU to make sure that students (both males and females) and employees understand the sorts of behavior proscribed by discrimination laws and policies, and provide safe avenues for them to report inappropriate and illegal behavior. Finally, reporting only is not sufficient; the perpetrators should be investigated according to the law and punished, if found guilty. The sentencing/punishment should be widely publicized within the affected organization, providing a show-case of retribution for doing or even attempting such things.

5. Conclusions

The primary goal of this study was to create a rough sketch, and not a detailed and polished portrait, of the female undergraduate engineering learning experience, using a variety of research methods and relying on the students 'own words for much of the data.

Based on the findings, it is apparent, that the female students, indeed, faced numerous gender-related challenges and even harassment from teachers and classmates in studying at SOE. The findings presented are essentially tentative, exploring the women's experiences from a gender perspective only (in part to ensure anonymity of the women), and should not be interpreted as representational of all females' experience of engineering education. The study, however, attempted to contribute, in its small way, to the growing body of knowledge on `predicament of women and engineering education'.

Women bring a much desirable and exceptional zest to engineering and therefore they should be supported, motivated, protected, respected, appreciated, and promoted. Although currently the female students at SOE make up on average 13.9 %, there is still need for much more females in engineering in order to satisfy ever-growing demand for gender-balanced engineering workforce. Diversity of the student body at academic institutions has immediate economic benefits. In an age where many academic institutions compete for enrolments, in particularly in engineering, not drawing on the pool of women, for example, reduces revenue. Equity, however, does not just mean an equal number of women and men; it means equal chances of success and career opportunities and development.

On the other hand, women must face challenges courageously, discover their-talents and skills, and believe in themselves!

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