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Female Underrepresentation in Undergraduate Education:

Case study in School of Engineering

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Abstract

It is an eminent and established reality that worldwide, women are underrepresented in science, engineering and technology (SET) subjects in university education. Concerns about underrepresentation of females in the SET fields in Kenya have been raised and expressed by the government and various organizations for a long time. Equal representation between men and women in SET, and particularly in engineering, is crucial, as it would help in better reflection of the needs and interests of both sexes and provide a superior and more diverse talent pool to the economy and workforce of the country. The goal of the current study is to merge an examination of gender disparity in enrolment and progression at the School of Engineering (SOE), Moi University (MU) with reviewing current interventions to attract more females to university programs in Kenya. This analysis is based on retrospective longitudinal data (2003-2014) for engineering programs-level admission & graduation and institutional-level admission alongside with retention, Engineering parity index and Proportionality index computation. Multivariate regression analysis was used to study association between graduation outcomes and institutional characteristics. The major findings of the study are: While MU total admission is steadily increasing, no explicit trend in total enrolment of SOE was established. Analogous, there is no predetermined pattern in female admission for both SOE (13.9% average) and MU (45.4% average), however they are both skewed in favor of male. 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. Total retention rate, SOE was found to be 0.9 (10% drop-outs). 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. Engineering female 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. The situation in SOE is more distinct as the admission ratio of F/M is 0.143, meaning that for every 7 male students admitted to SOE there was only one female student. These trends suggest that females' participation in engineering professions is likely to be affected. This gender imbalance presents a missed opportunity and if we are serious about addressing the engineering skills shortage systematic intervention into the education system and graduate supply is required. In this regard, the study made numerous recommendations, the two main ones are: proposal to establish a national policy to attract more females to universities, in general, and to engineering programs in particular; and the second - is using a social media to reach youth, especially females, by establishing and running an "Engineering 101" website/blog/online-forum that is focused and features on engineering and gender.

Key words: Females, Gender underrepresentation, Engineering education, Interventions.

1. Introduction

1.1. Global outlook on female underrepresentation in STE education.

The role of Science and engineering in improving quality of Life is now more prominent that ever. According to the United Nations Education, Scientific and Cultural Organization (UNESCO), women's active inclusion and participation in science is crucial in countries' efforts to alleviate poverty. Encouraging women to take part in science and engineering would allow any country to maximize its valuable human assets, empower its women, and improve its economic prospects. Helping countries collect analyze and disseminate statistics on science, technology and gender; puts gender issues in science on policymakers' agendas. UNESCO has called on the international community to help countries gather these data and put in place strategies for increasing women's participation in science and technology. Reliable evidence can inform policy by helping policymakers identify areas to target for intervention (UNESCO, 2007).

In today's ever-intensifying innovation-driven economy, science, technology, engineering, and mathematics (STEM) fields play a crucial role within any country seeking to ensure competitiveness and market viability. Developing a vibrant STEM workforce and maximizing its potential in such an environment invoke many related policy issues, often involving questions about the profile and nature of that workforce. Many of these questions are concerned with notions of gender equity and the underrepresentation of women (UNESCO, 2000). Engineering has continued to remain one of the most

male-dominated professions around the world with male bias in undergraduate engineering student cohorts still evidenced (UN, 2010). The call for action to narrow the gender gap in STE has grown stronger, especially with gender equality being named by the United Nations as one of its eight Millennium Development Goals (MDGs) in 2000 (UN, 2010). In the view of the above, numerous studies have been initiated to address female underrepresentation in SET internationally as well as in Kenya.

Low female participation in engineering and technology education and other STEM-related fields is a documented world-wide problem in education, industry, and government (Bybee & Starkweather, 2006; Gordon, 2007; NSB, 2006; Plonski & Saidel, 2001; Roger &Duffield, 2000; van Langena, Boskerb & Dekkers, 2006; Ernest, 2003; Bryson et al., 2003; Hazzan, Tal & Keida, 2006; Jenkins & Pell, 2006; Petrina, 1998; Rathgeber, 2002; Masanja, 2001; Onokala & Onwurah, 2001 among others). Country-level studies have been done by Nyamu, 2004; Nungu, 1994; Onsongo, 2007 and Onsongo, 2008 among others. One fact that is evident from various research findings is that the higher the level of education, the wider the gender gap. In Kenya, studies by Otieno (2001), Ngome (2003), and Bunyi (2004) all agreed that the higher the level of education, the wider the gender gap in favour of males.

The minority of women's participation in engineering programs has been also well reported and discussed in feminists' works nearly all around the world. Previous studies have identified various historical reasons leading to this phenomenon. The mostly agreed factors in the history of different western countries include:

1) Women's unsuitable gender role, which keeps the ideology of femininity distant from technology and engineering (Smyth, 2005; Kvande, 1999; McIlwee &Robinson, 1992)
2) Gender stereotypes in labour division, which defines engineering as a male-oriented profession (Lackland& De Lisi, 2001; Hersh, 2000; Kvande, 1999; Berner & Mellstrom, 1997; and Frehill, 1997)
3) The traditional lecturer-based learning environment at engineering programs overweighs sophisticated natural science knowledge and hard-core technological skills, which mainly favors male interest and expectations and ignore women's experiences and concerns (Du, 2006; Salminen-Karlsson, 2002; Seymour& Hewitt, 1997; Tonso, 1996; and Hacker, 1989).

1.2. Kenya: Relevant background

According to Global Competitiveness Report, 2012–2013 Kenya is an East African country with a population of 41.8 million people. GDP per capita (US$) 832.5 (4% of USA), with sectoral value-added (% GDP), 2011 being Agriculture 23.1, Industry 19.2 and Services 57.7 with over 70% of people work in agriculture.

Population doubling time 29 years, Population under age 15 is 42%, Rural/urban split 78% rural/22% urban, Gender balance(rural) 97 men to 100 women, Illiteracy (rural, 2007) 30% women and 18%men (large variations), Gender differences by region High (Kenya and Gender@ a Glance, 2013).

The Kenya's Gender Inequality Index score is 0.627 (130th out of 146 countries) (World Economic Forum, 2011). Kenya is placed 99th in the 2011 Global Gender Gap Index, with a score of 0.6493. Tertiary Enrolment Ratio (m/f) 4, Women in Parliament (in %)18.6, Gender Equity Index 104/168 (CEDAW, 2006). The Quality of Education system of Kenya is ranked high being 37 out of 144 (Global Competitiveness Report, 2012–2013). At the time of this study, there are following accredited universities in Kenya: 22 Public Chartered Universities, 9 Public University Constituent Colleges, 17 Private Chartered Universities, 5 Private University Constituent Colleges, 13 Institutions with Letter of Interim Authority(LIA) and 1 Registered Private Institution (Education in Kenya, 2015). There is an estimated 122,874 university students in the country of which approximately 80 percent are in public universities (Kenya National Bureau of Statistics, 2009).

1.3. Underrepresentation of Engineers in Kenya (problem statement and justification of the study)

Between 2000 and 2004, the number of female students admitted in the universities was 3836. In 2007, the enrolment at secondary education stood at one million. About a quarter of these students sit the Kenya certificate of Secondary Education Examination (KCSE) but only about 25,000 join public and private universities. Gender disparities are apparent in the admission of students to universities. In 2007, female students in the public universities comprised of about 37% of the total student population. An estimated 22% of Kenya's 45,000 university students' and 5% of students in postgraduate institutions are women. Only 20% of female students are enrolled in science and technology courses (Republic of Kenya, 2008).

During the 19th Engineers International Conference in 2012, the issue of Gender imbalance in the Engineering Sector was highlighted. At a local context, according to Starovoytova (2015) there is a deficit (minimum of - 216%) of Engineers in Kenya. Huge mismatch between supply and demand of Engineers in Kenya is apparent, which in turn challenges Kenya's higher engineering education system. This means that there is an urgent need for developing a significant mass of Engineers and Technologists to reduce the existing deficit gap.

Data extracted from Musau & Kirwa (2012) shows that in Institution of Engineers of Kenya (IEK), female Engineers constitute: Fellows Engineers 1.2%, Corporate Engineers 1.4%, Associate Engineers 0%, and Graduate Engineers 3.4%. Similarly, female representation at Engineers Board of Kenya (EBK) is as

follows: Registered Consulting Engineers 1.8%, Registered Professional Engineers 3.2%, Registered Graduate Engineers 7.7%, and Graduate Technicians 1.5%.

Compiled data from Musau (2012) affirmed that the enrolment of female students for undergraduate programs at MU (2003-2008) had a declining trend (from 44 to 41%). In the SOE, MU the situation of female underrepresentation is even much more noticeable. In 2008, a baseline survey was conducted (under VLIR_MU project): "School of engineering, comparison by gender between staff and students baseline survey, academic year 2008". Based on the assessment of five years data (2003-2008) it was identified that female representation in regular programs was fluctuating between 18% and 12%, with the 5 year mean of 15%, while in Privately- Sponsored Students Program (PSSP) it was steadily declining from 21% to 14%, with the 5 year mean of 17%. The major conclusion of the survey was that the gender balance among engineering students still remains much skewed in favour of men. Part of contributing factors includes the high cluster-points required to join the various programs with minimum requirement pegged at 41.5 points out of possible maximum of 48.

Critically, these figures indicate that there will never be sufficient numbers of women engineers to reach the critical mass in Kenya unless effective interventions are put into action. The critical mass being *"a minority group within a population (especially one that has traditionally been discriminated against) is easily marginalized; its continued presence and survival is in constant jeopardy often requiring outside intervention and assistance to prevent extinction*" (Etzkowitz et al., 1994).

In the view of the above this paper will therefore elaborate on women's underrepresentation in engineering education and also review various interventions currently undertaken to tackle the issue of female underrepresentation in education in Kenya. This article is an account from a larger gender-related study based on SOE, MU. The data obtained from gender analysis will help in the formulation of appropriate gender responsive policies, programs and projects which will address the specific needs of engineering capacity- building, to sustain and propel Kenyan economy. The study is significant because it adds to the existing body of knowledge that examines low female enrolment in engineering and technology education. Additionally, as a result of the study, the researchers anticipate encouraging gender-equity in engineering and technology education programs across Kenya and abroad, that will attract and retain students of both genders. The primary audiences for this article are those policy makers, legislators, educational leaders, and educational and scientific organizations who work to enhance the preparation and diversity of Kenya's future engineers.

2. Materials and methods

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 in 1984 by the Moi University ACT CAP 210A after recommendations from the Mackay Commission. It started off with one school of 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 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) (MU official website, 2015).

To study the representation of women in SET in higher education, statistical information is often the simplest indicator of change. Data on admissions was collected from MU and SOE statistics, while graduation data was limited to SOE only. MU and SOE enrolment register, university administrative reports, graduation almanacs and MU Senate records among others were examined throughout the data collection process. To draw inferences from the collected retrospective primary data, the statistics was coded, summarized, interpreted and analyzed by SPSS software. Comparison of admission and graduation rates was made via descriptive statistics and also by calculating the retention rate, parity engineering index and proportionality index. Multivariate regression analysis to study association between graduation outcomes and institutional characteristics is used. The retrospective data was restricted to the period between 2003 and 2014. More sophisticated analysis than looking simply at enrolment figures was used. Three different measures applied to assess women's participation in engineering over time are: the number of women studying engineering (F), the proportion of those studying engineering who are women ($F/ (F + M)$), and the engineering parity index ($F/$ [total F]). Each of these statistics is an indicator of women's participation in engineering, yet each yields very different results, particularly when examining trends and assessing progressiveness and persistence of gender imbalance. Furthermore the secondary sources of data were utilized to contribute to validation of the findings.

2.1. Retention

The most prevalent measure of performance is retention rate, whose family of indicator is graduation rate. Retention is a precondition of graduation but graduation is the ultimate goal of retention. Individual longitudinal data was collected on students enrolled in engineering to track outcomes overtime, including progress, and yearly retention. Retention is measured here as the number of students who graduate from a

program divided by the number of students who enrolled in the program five years earlier. Male and female retention are calculated separately. Retention is calculated by the following formula 1 (Decohen &Deterding, 2009) as the sum of students of gender *s* who graduated from institution *i*, in discipline *j*, in year *y* divided by the sum of students of gender *s* who enrolled at institution *i*, in discipline *j*, in year *y-5*.

$$\text{Retention} \Rightarrow \overline{R}_{sy} = \frac{\sum_{i,j}^{N} G_{sijy}}{\sum_{i,j}^{N} E_{sij\,(y-5)}}$$

where
G = number of students graduated
E = number of students enrolled
s = gender
i = institution
j = discipline
y = years

(Formula 1**)**

2.2. Engineering parity index
Engineering parity index is calculated by the following formula 2 (Decohen &Deterding, 2009).

$$Engineering\ parity\ index = \frac{Total\ females\ admitted\ in\ SOE, MU}{Total\ females\ admitted\ in\ MU}$$

(Formula 2**)**

2.3. Proportionality index
The proportionality index is calculated by the following formula 3 (Decohen &Deterding, 2009) as the average percentage of women graduated in year *y* divided by the average percent of women enrolled in year *y-5*.

$$\text{Proportionality Index} = \frac{\dfrac{\sum_{i,j}^{N} G^{f}_{ijy}}{\sum_{i,j}^{N} G_{ijy}}}{\dfrac{\sum_{i,j}^{N} E^{f}_{ij\,(y-5)}}{\sum_{i,j}^{N} E_{ij\,(y-5)}}}$$

where
G^f = number of female students graduated
G = number of students (males and females) graduated
E^f = number of female students enrolled
E = number of students (males and females) enrolled
i = institution
j = discipline
y = year

(Formula 3**)**

Gathering, presenting and articulating this information are essential in establishing the rationale for concerted action to redress the female underrepresentation in engineering education.

3. Results

3.1. Data analysis SOE, MU
The retrospective data collected from SOE and MU was compiled, codified, and analyzed. The results are summarized and presented graphically as Figure 1, Figure 2 and Figure 3:

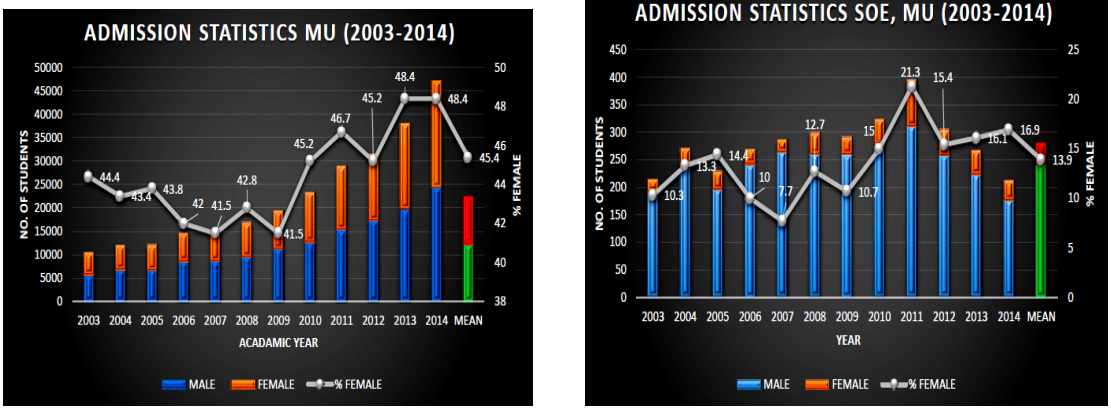

Figure 1: Admission statistics and female% (2003-2014) for MU (*left*) and for SOE, MU (*right*).

Figure 2: Total number of students admitted (*left*) and graduated (*right*) SOE, MU (2003-2014)

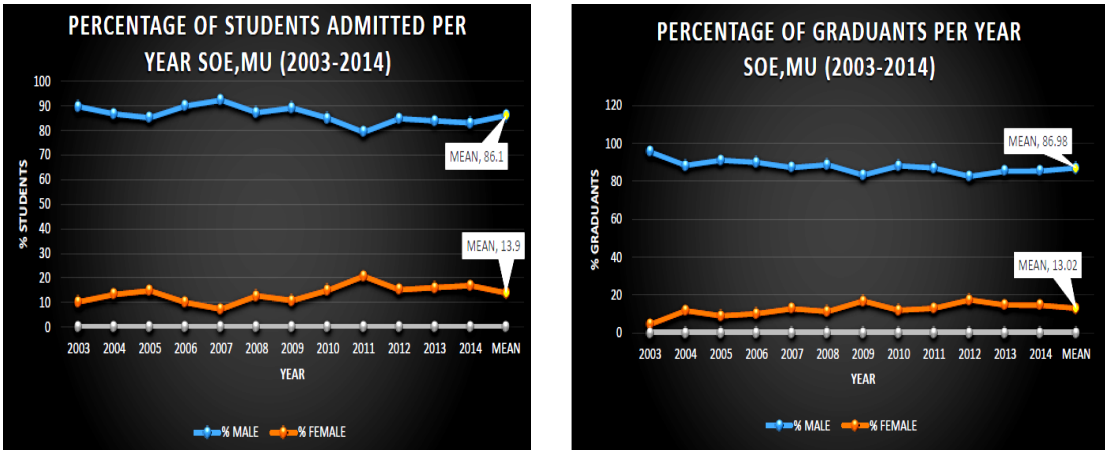

Figure 3: Students admitted (*left*) and students graduated (%) (*right*) SOE, MU, (2003-2014)

Engineering parity index was found to be 0.017, while female engineering parity index was found to be 0.0038. Total retention rate, SOE (2003-2014) is 0.9, while retention rate for females was found to be 1.14 and for males it is 0.87. F/ (F+M) admission ration is 1:7 and Proportionality index was found to be 1.3.

3.2. Interventions

Interventions to attract more females to engineering in Kenya are discussed below; these are superficially subdivided into policy and legal issues, and actions. The findings recorded below do not claim to be fully comprehensive account of every instance associated with gender underrepresentation, but they do give a fairly good picture of the order of magnitude of activities, achievements, and problems encountered, and probably include the most significant ones identified for which information was available at the time this study was carried out.

3.2.1. Relevant Policy and legal issues

According to Republic of Kenya (2007) gender issues in education were addressed through several Government of Kenya (GoK) documents, and in particular: the Poverty Reduction Strategy Paper (2001), Economic Recovery Strategy (2003-2007), National Development Plan (2002-2008), Sessional Paper No.1 (2005), Kenya Education Sector Structural Program (2005), Ministry of Education Strategic Plan (2006-2011) and the Kenya Vision 2030 (2007) among others. Kenya is also a signatory to international protocols relating to education and human rights of women and girls, including the Universal Declaration on Human Rights (1948), Convention on the Elimination of all Discrimination Against Women (1979), Convention on the Rights of the Child (1989), Jomtiem World Conference (1990), Beijing Declaration and Platform for Action (1995), Dakar Framework of Action of Education for All (2000), Millennium Development Goals, and Goals of the African Union among others.

A new Constitution for Kenya was approved by 67% of Kenyan voters in 2010. The Constitution includes a clause defining discrimination, and stating that the state will not discriminate against any citizen on the basis of a number of social categories, including gender (CEDAW, 2006). The new Constitution of Kenya, 2010 calls and encourages gender equity with the one third rule across all sectors especially in

leadership and representation amongst other benefits. In Article 27, Sub section 3 of the Constitution provides for the right of equal treatment as well as the right to equal opportunities in political, economic cultural and social spheres.

Kenya Vision 2030 is the country's new development blueprint covering the period 2008 to 2030. It aims to transform Kenya into a newly industrializing, "middle-income country providing a high quality life to all its citizens by the year 2030". Second annual progress report on the Implementation of the First Medium Term Plan (2008-2012) Kenya Vision 2030 stated that the proposal on establishment of Gender Research and Documentation Centre was developed, National Framework for monitoring sexual and gender based violence was also developed.

In 2007, the Gender Policy in Education was officially launched and disseminated to the implementing entities. Gender policy was worked out with various stakeholders in education, including Development Partners particularly USAID, Girl Child Network, Forum for African Women Educationalists (FAWE-K) and others.

3.2.2. Gender-related interventions in university education in Kenya.

The major gender-related interventions in education in Kenya are summarized in Figure 4, followed by elaboration on the same

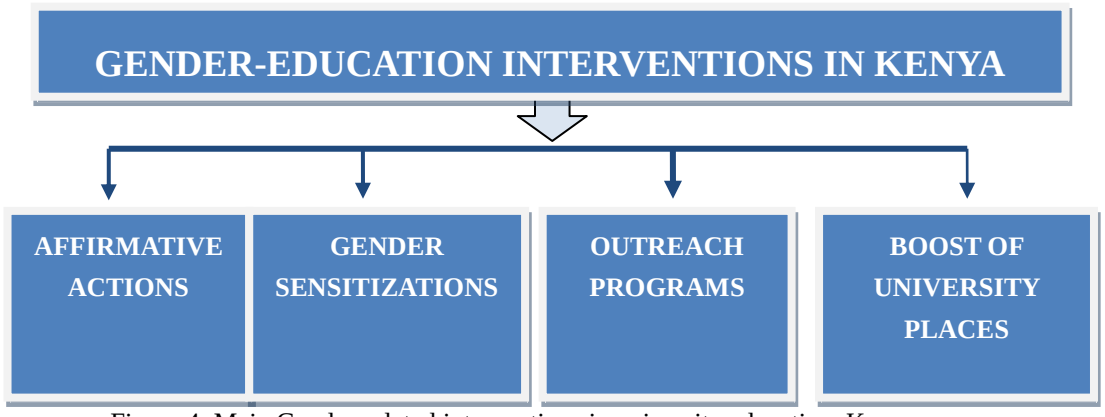

Figure 4: Main Gender-related interventions in university education, Kenya
Source: Extracted from Bunyi, 2003.

3.2.2.1. Affirmative Action (AA)

Affirmative action refers to a body of policies and procedures designed to eliminate discrimination against marginalized groups including ethnic minorities, and women. Its main objective is to redress the effects of past discrimination (Wanyande, 2003). AA consists of the following two strategies:

a) *Lower admission cut- off points for females:* Such policy allows female candidates who have attained the minimum required marks to enter public universities at one (1) point below males (Joint Admissions Board, 2002).
b) *Bridging courses:* Such courses are offered for particular tertiary programmes or subjects. The courses are offered to female students who have met the overall mean grade criterion for admission into university but who do not meet the specific discipline requirements in mathematics, English and physics. With liberalization of tertiary education, pre-university courses are now offered in private universities and in the self-sponsored programmes in public universities in Kenya.

3.2.2.2. Gender sensitization

Different interventions have been implemented in an attempt to make the tertiary institutions more women-friendly. These include:

(a) *Establishing of Gender Institutes, centers, departments, studies, and research*. The idea has been to use the research findings as a basis for advocacy for gender equity.
(b) *Combating Sexual Harassment (SH) and violence*. Institutional structures for dealing with SH have been put in place. They include: Gender Equity Units, Gender Forums, Anti-Harassment forums, Women's Advice Desks, Gender committees and Gender Task Groups. Interventions dealing with Elimination of discrimination, harassment and victimisation, Advancing equality of opportunity (including by removing or minimising disadvantages, taking steps to meet different needs and encouraging disproportionately low participation) and foster good relations and mentorship with successful female professionals.
(c) *Providing appropriate accommodation for female students*
(d) *Increasing the number and raising the levels of women academics and administrators.* Interventions in this area have included: Development of gender equity in employment policies, Establishment of equal employment opportunity offices, Increasing the quantity and quality of women postgraduate students as an intervention for increasing women in faculty and university management.

(e) *Confidence self-esteem building* **(**trying to change people's beliefs about and attitudes towards women). This is done through gender-sensitization seminars, conferences and workshops, which have been organized in most universities.

3.2.2.3. Outreach Programmes

This is usually done by academic members of staff with the aim to market to secondary school students a specific school/department/program/area of specialization.

3.2.2.4. Boost of Universities enrolment places/capacity

Several approaches have been used, such as: opening of private universities and expansion of existing ones, introduction of privately-sponsored programs in public universities, introduction of flexible course offerings, and diversification of the methods of delivery among others.

a) *Women's only universities* are logically regarded as safer environments for girls. These considerations have recently led to the opening of the Kiriri Women's University for Science and Technology.
b) *Private Universities* provide much needed access to tertiary education for both men and women. For example, in Kenya, private universities take up approximately 14% of the total number of students who qualify to join universities (Brown, 2001).
c) *Flexible time of classes.* Some universities have already established part-time and evening programs, where students can work in the daytime and attend classes in the evenings and on week-ends.
d) *Self/privately-sponsored programs*. They constituted about 26 % of the admissions in public universities in Kenya of whom 40% of were women compared to 29% in the regular group (Mwiria & Ng'ethe, 2003).
e) *Diversification of the methods of delivery* is done by, for example, distance and open-E-learning programs/courses. The term Open and Distance Learning (ODL) covers the various forms of contemporary education themes such as e-learning, lifelong learning, open-learning, mobile and flexible learning. In Distance Education (DE), learning occurs at levels where there is no continuous immediate interaction of teachers, tutors, lecturers or professors with students/learners in the same premises. The philosophy of Open, Distance Learning (ODL) system is characterized by removal of barriers such as lack of access, quality, and equity to education. This allows learners to study what they want, when they want, where they want and whatever age they want it. ODL be used as a vehicle for promoting the culture of life-long learning by establishing continuing education programmes in areas of Kenya where such programmes have not been initiated, especially the ASAL areas.

4. Discussions

4.1. Data analysis of SOE, MU statistics

In Figure 1(*left*), the total number of students admitted to MU for the focus period has being steadily increasing. The highest number of female students admitted is 22, 814 in 2014 and the lowest is 4,643 in 2004. The highest percentage of females admitted in the university is 48.4% in 2013 and 2014, while the lowest is 41.5% in 2007 academic year. The mean number of female students admitted annually in MU is 10,169 (on average 45.4% of the total). Although the admission of female students to MU has been increasing from 41.5% to current 48.4%, it is still skewed in favor of male students.

In Figure 1(*right*) the highest number of females admitted to SOE was 84 in 2011 while the lowest was 22 in 2007. The mean number of females admitted to SOE was 36. The highest percentage of females admitted was 21.3% in 2011 and the lowest was 7.7% in 2007. From Figure 3(*left*) the mean annual percentage of females admitted to SOE year is 13.9%. From Figure 2(*right*), the highest number of females graduated at SOE was 41 in 2009, while the lowest was 3 in 2003. The mean number of females graduated in SOE for the subject period was 26. The mean percentage of females graduated per year is 13.02% as shown in the Figure 3(*right*).

The enrolment and graduation pattern in SOE, MU programs within the span of 12 years revealed that female enrolment and graduation was significantly lower than that of males. This trend suggests that females' participation in engineering professions is likely to be affected.

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 and MU, however they both skewed in favor of male students. Tthe situation in SOE is more distinct as the ratio of F/M ration of admission in SOE is 0.143, which equal to ratio of 1:7, meaning that for every 7 male students admitted to SOE there was only one female student.

MU was established as first technical university in Kenya, and logically it would be expected that SOE should be one of the largest schools, however ironically this is not the case, as representation of engineering students in total population of MU students is only 1.68 %, meaning that for every 59 students admitted to MU there will be only one student admitted to SOE. Engineering female 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.

Over the past twelve years, gender representation in SOE has remained relatively unchanged, with females making up on average only 13.9% of all engineering students.

Total retention rate, SOE (2003-2014) was found to be 0.9, while retention rate for females was found to be 1.13 and for males it is 0.87. It means that 10% on average of female and male students do not graduate. Females' retention ratio was found to be 1.13 and in parallel the proportionality index that was found to be 1.3; which, in theory, means that the number of female students in graduating cohort is greater than the share of females in its corresponding incoming cohort (5 years earlier). However, this declaration had to be examined further to establish the reasons behind this abnormal phenomenon. The assessment revealed that normally MU students are allowed to transfer to other Schools after the first year of study. The policy of MU (of 28th October 2009 section 6) which regulates the transfer is as follows:

i.) Candidates who have passed in first year of study may be allowed by senate to transfer only once, to other program(s) of their choice in the second year of study, provided that they meet the entry requirements for that or those programs. Such candidates may be given credit transfer from passes obtained from previous courses to be taken in the new programs.

ii.) Candidates who have failed in their first year of study may be allowed by senate to transfer to a program or programs of their choice only once, provided they meet the entry requirements for that or those program(s) but they shall not be given credit transfers.

iii.) Candidates in second and subsequent years, who have failed and have been discontinued in one program, may be allowed by senate to transfer to another or other programs of their choice, provided that they meet the entry requirements for the said programs. Credit transfers shall be given where appropriate.

In addition to transfer, students can repeat a year based on an academic ground and they can also defer their study based on any of medical, financial, or compassionate grounds. While the repeat of the academic year can be authorized only once per the same academic year, currently at MU there is no policy on deferment of studies, meaning that student can defer for one year, come back and defer again, and so on. In the final analysis, the additional female students in graduation class might have been the ones repeated one or several years of study, or they might be back after deferments of their study, which is particularly difficult to analyze, due to deficiency of records on such progression. In addition, during data collection, authors faced several complications, namely: absence and or fragmentation of records and in some cases unwillingness of the administrative staff first to locate and then to deal with old archives. In addition, in many cases even if the data was available, it was not gender-segregated. Inadequate gender-segregated data covering not only enrolment, graduation but the most importantly progression from year to year, reasons for repeat, dropout and deferral of studies affected data examination of SOE females' retention and consequently it was inconclusive.

The data presented in this paper raise serious questions about the future of Kenya's engineering, as the nation needs extra, well-prepared and diverse, engineering workforce. On the other hand, there has been little change in female representation in SOE. The analysis also illustrate that the underrepresentation of women in SOE continues to be both progressive and persistent as seen when Engineering parity index is used. The comparison of female admission trends at SOE at 13.9% on average revealed that the persistent underrepresentation of women in engineering is perplexing, particularly when female representation in other fields (see Figure5) has enjoyed superior improvement over time.

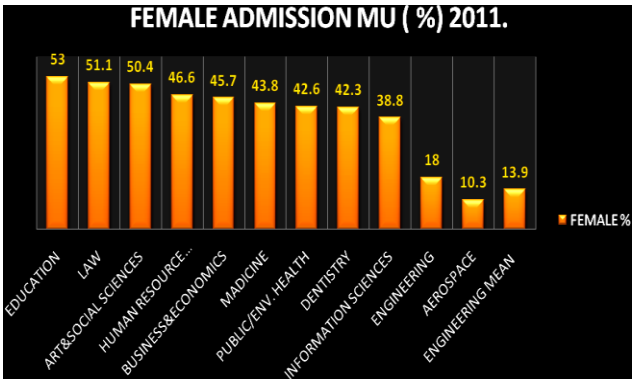

Figure 5: Female admission MU(%), 2011
Source: Extracted from Butcher& Safuna (2012)

On the other hand, this trend of underrepresentation of females in engineering is consistent with the

findings on female representation in engineering education from several other countries (e.g., United States 19.3%, Canada 18.5%, Australia 14.1%, Japan 11% and United Kingdom 9.5%) which show that participation rates of women students in engineering have leveled off, and in some cases even started to decline, in recent years (European Commission, 2006). This only confirms that female underrepresentation in engineering is indeed a global phenomenon of great concern.

Various researchers tried to identify the root-causes behind this problem of female underrepresentation at SET fields. This, however, was outside the scope of this concise study; yet the authors feel that the information below could add some value and provide more clear comprehension on the subject matter.

4.2. Well-documented barriers to female underrepresentation

As suggested by many authors, the causes of women's underrepresentation in SET appear to be a complex web of interdependent factors, such as those listed below: Engineering and Technology education perceived as a male-dominated field (Bryson et al., 2003); Disenfranchisement of female Engineering and technology education teachers and students (Bryson et al., 2003); Loss of interest among females in Engineering and technology education classes after primary school (Jones et al., 2000; Silverman & Pritchard, 1996); Lack of female role-models and mentors in Engineering and technology education (Committee on the Status of Women Faculty at Caltech, 2001; Gilbert, 2001; Jovanovic & King, 1998; Massachusetts Institute of Technology, 1999); effects of stereotypes about Engineering and technology education (Clewell & Campbell, 2002; Greenfield, 1996); sexism and gender-bias in Engineering and technology education programs (Brickhouse, 2001; Committee on the Status of Women Faculty at Caltech, 2001); Lack of knowledge of career options (Bryson et al., 2003; Silverman & Pritchard, 1996); Effects of teacher gender on female choice of classes (Bryson et al., 2003); Funding and other administrative support (Bryson et al., 2003); Biological differences (Clewell & Campbell, 2002); Parental expectations and input (Clewell & Campbell, 2002); Effects of guidance counselor and teacher discouragement (Bryson et al., 2003), and female lack of confidence and self-efficacy (Clewell & Cambell, 2002; Wyer & Adam, 2000). Other individual barriers according to Cubillo (1999) include: the tendency among women to avoid where they risk facing criticism or receiving negative feedback; fear of failure and hence a reluctance to voice their opinions; excess responsibilities and fear of conflict and loneliness; self-doubting; and a different (feminine) style of management. In addition Cronin(1999) included the following barriers: The image of SET subjects (e.g., masculine, concerned with things rather than people), particularly in engineering, computing and physics); The stress and isolation of being in a minority; Negative attitudes of male peers, lecturers and other staff; Narrow course content; Didactic teaching approaches; Lack of opportunities for cooperative or interactive learning; Emphasis on individual competition; Inadequate counseling and advising and Concerns about combining a SET career with having a family. Chubin &Babco (2003) also identified a number of factors, such as failing to explain how engineering can improve others' lives, a lack of awareness of what engineers do, and discomfort of being in a male-dominated environment and the perception that women must adapt to fit in.

4.3. Fundamental approaches and Past recommendations to overcome the barriers

Three well-known fundamental approaches to address female underrepresentation in education are: The 'tinkering' (legislative approach), the 'transforming' academic culture approach (to transform artefacts, espoused values and underlying assumptions) and the 'tailoring' (or positive action) equal opportunity approach. Comprehensive coverage of the fundamental approaches can be found in (Trower, 2004).

Additionally, numerous researchers also made suggestions for overcoming these barriers. Those solutions include: hire and provide more female mentors and role-models for female students in technology education (Gilbert, 2001); examine arrangement of engineering and technology education classes (Silverman & Pritchard, 1996); encourage guidance counselors to provide female students with information about technology education classes (Silverman & Pritchard, 1996); examine the possibility of making systemic changes in technology education curriculum and instructional strategies (Bryson et al., 2003) and provide extra-curricular technology education experiences for females (Livingstone, 2004; Gilbert, 2001) among others.

4.4. Discussion on Interventions

4.4.1. Policy and legal issues

The new Kenyan Constitution (2010) gives a very critical treatment to gender. It seeks to renounce the historical exclusion of women from the mainstream society. It strikes at the socio-legal barriers that Kenyan women have faced over history. Article 27(8) of the constitution stipulates that the state shall take legislative and other measures to implement the principle that not more than two-thirds of the members of elective and appointive bodies shall be of the same gender.

In the past, the government has had a number of on-going initiatives to address gender gap at all levels of education including management such as: appointment of qualified female educational managers; gender balanced intake of pre-service teacher trainees; gender responsive deployment of teachers; engendering the curriculum; capacity building for school managers, teachers and quality assurance officers on gender issues;

and the Ministry of Education has also established a National Task Force for Gender and Education, a Ministerial Task Force on Girl's Education and a Gender Desk (Republic of Kenya, 2007).

Policy Framework for Education, Training and Research outlined in the Sessional Paper No. 1 of 2005 developed a Gender Policy in 2007. Among its specific objectives were to: increase participation of women in governance and management of education; mainstream gender at all educational levels, institutions, policies, programs and activities, planning, implementation and budgeting; ensure institutional work environments are gender responsive; and to empower girls and boys, women and men on gender issues (Republic of Kenya, 2007).

Sessional paper no. 2 on Gender and Development (2006), which supports the implementation of measures like affirmative action in the admission of girls to university, re-entry of adolescent mothers to school and enhanced bursaries for girls' education. It also promotes a review of curriculum and teaching materials to ensure gender sensitivity (Republic of Kenya, 2006).

In July 2007 the Ministry of Education launched a Gender Policy. This included commitments to enhance access and gender equity in universities through affirmative action and provision of grants and loans (Republic of Kenya, 2007). But to date the policy has not been widely disseminated and limited resources have been allocated for implementation (Onsongo, 2008).

In Kenya Vision 2030 mid-term progress report part 5.1 Education and Training stated that public and private universities will be encouraged to expand enrolment, with an emphasis on science and technology courses. In addition one of the flagship Projects for Education and Training mentioned is to create "Centers of Specialization" for each of Vision 2030's economic growth sectors. In section 5.6 Gender, Youth and Vulnerable Groups it stated that specific strategies will involve increasing the participation of women in all economic, social and political decision-making processes- improving access to education.

4.4.2. The Gender related interventions in university education in Kenya.

4.4.2.1. Affirmative Action

Lower admission cut- off points for females

Kenya Universities and Colleges Central Placement Service (KUCCPS), (the body that replaced the Joint Admissions Board - JAB), oversees all students' admissions to public universities, has been lowering the cut-off points for university entry for females by one point.

Research done on gender equity interventions in higher education has shown that academics working in universities have varied views of affirmative action (Lihamba et al. 2006; Morley 2004; Morley et al. 2006; Onsongo 2011; Kanake 1997; Nungu 1994). While lowering cut-off points affirmative action interventions has increased women's enrolments, it faces the problem of acceptance. Critics argue that this 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. Although there is no legislation requiring universities to implement affirmative action, temporary affirmative action measures have been used by Kenyan public universities to increase access for women students. For instance, the Joint Admission Board of Kenya (JAB) for public universities in 2002 lowered the cut-off points for girls to B+ of 68 points instead of 69 points to accommodate an extra 224 female students in public universities. This raised the initial number of female students from 2,547(25.63%) to 2,771(27.27%) (Njihia, 2005). This was against a population of 7,392 male students who had acquired B+ grade of 69 points (JAB Sub Committee, 2002). Although the lowering of one point in university admission for girls has since become a policy, gender disparities are still very visible within universities (Kanake, 2007).

Bridging courses

In Kenya, a newly established (2003) private women only university, St. Lucie Kiriri Women's University of Science and Technology, among other Kenyan universities, is offering three months bridging courses in mathematics, English and physics with the objective of enabling female students attain entry qualifications for competitive STEM courses in the universities and other tertiary institutions.

Bridging courses do not appear to attract as much debate as the lowering of cut-off entry points. They may also be more beneficial to the women candidates, enabling them to opt for specific remedial courses of their weakness areas and therefore preference. However, elevated tuition-fee is a severe problem linked with the bridging courses intervention.

4.4.2.2. Gender sensitization

Establishing of Gender Institutes and centers

According to Keino (2002) the gender centers have been found to be ineffective in enhancing gender equity in the universities in which they have been established. This is because the centers operate in isolation from other departments and the mainstream activities of the universities. They lack adequate staff and resources to run gender sensitization programs on campus and the staff employed (directors) are women who sometimes lack knowledge and interest in gender issues. Molestone (2004) concluded in his study that it might be difficult for these centers to enhance gender equity if they are not incorporated in the mainstream

activities of the universities. Second annual progress report on the Implementation of the First Medium Term Plan (2008-2012) Kenya Vision 2030 also stated that some Gender Divisions in Line Ministries and Parastatals are ineffective or non-functional due to lack of adequate capacity and resources.

At MU, for example, to address gender issues the Institute for Gender Equity Research and Development (IGERD) was launched at 3rd November, 2005 with a mission to advocate, develop and promote gender equity in all university programs and activities.

VLIR-UOS is the Flemish Inter-university Council-University Development Cooperation which has established MU-K IUC Partnership in 2007 and Gender mainstreaming was considered central in the project along side capacity-building for staff. Gender mainstreaming was undertaken under the Gender equity project (GEP). The MU-K IUC operates within the broad national and university strategies which include among others; the Kenya Vision 2030, the National Strategy for University Education, 2007-2015 and the Moi University Strategic Plan 2009/2010-2014/2015. The Mid-Term Evaluation of the Flemish Institutional University Cooperation with Moi University (MU-K IUC) was carried out by an Evaluation Commission consisting of international expert Neil Butcher (South Africa) and local expert Professor Daniel Sifuna (Kenya). Phase I of the MU-K IUC has consisted of six projects, one of which is the Gender Equity Project (GEP). GEP was designed to facilitate the MU's efforts to adress gender equity, as well as factors which fuel gender disparities both at the university and in selected communities in Western Kenya. According to Butcher & Safina (2012) the intermediate results for Phase I of the Gender Project, VLIR_MU were identified as:

1. Centre of excellence in gender, research and development is developed
2. Awareness on gender issues in MU and the community created
3. Gender representation at various levels of development and decision-making MU is improved
4. Synergy between Gender project and MU_VLIR-UOS other projects achieved.

In particular, there have been various outreach activities on gender issues to increase awareness. These include the newsletter, *Jinsia Agenda*, which is published periodically. Two issues per year are circulated to all MU-K offices and stakeholders. Advocacy materials have included: T-shirts addressing sexual harassment and gender violence produced in 2009 and shared with stakeholders; posters on gender issues originating from the essay-writing competition circulated and shared with stakeholders in GEP/IGERD forums; and a DVD on gender violence. There were also drama performances and one public talk with students at the Eldoret West Campus. In 2009, there was a road show/public engagement which covered 60km from the Main Campus through four towns, highlighting issues raised in the essay competitions. There have been numerous workshops and seminars on gender violence, including one with the Police Department.

To increase women's participation in university management structures, one workshop was held on gender and leadership for MU-K deans, heads of departments, and section heads in late 2010. There has also been publication of the *Moi University Gender Policy*, which addresses gender issues in the university. As a result of IGERD advocacy, three departments which did not have females on their staff had new female members hired in 2009. Female heads of departments increased from four to nine in the same year. GEP has also increased awareness regarding the need to implement government policy of increasing women representation in government and parastatal institutions by 30 percent. By 2009/2010 at least one woman sits in every university committee. By 2007, female students were below 40 per cent. Currently, they are above that figure, and, according to the Joint Admissions Board, the aim is to increase the numbers of female students, especially in the sciences. Affirmative action in admissions is now a policy in the Deans' Committee.

To develop into a centre of excellence, the Institute is engaged in a wide range of gender-related activities. These have included, among others: six people trained as TOTs on gender policy; 27 people trained on gender policy formulation; capacity of 25 IGERD board members in research built through the baseline survey and participation in university gender policy development; and 20 research assistants sensitized on gender issues in their capacity as research assistants. A needs assessment was held in five towns before developing short courses, which were followed by four validation workshops. Short courses were developed and published in a booklet among other activities.

From the authors' current perception there is no sufficient and reliable data available to confirm whether or not gender studies units are making any impact on women's enrolments, as presently at MU there is no policy on how to attract more female students to MU. On the other hand the centers (except IGERD at MU) were not very vocal and active in communicating their activities and achievements. Yet, they are generating considerable body of knowledge on gender issues in the institutions and elsewhere in the society, all of which, if carefully interpreted and findings implemented, the interventions can increase females' enrolments.

Combating Sexual Harassment (SH) and violence.

Combating Sexual Harassment and violence movement in some instances faced resistance as the largely male tertiary institutions' authorities are not keen about such initiatives. Even when women have been raped, they may not report the crime for fear of being labeled sexually loose because of the widely held

view that women ask for it by dressing provocatively for example. Further, sometimes, when female students report on SH incidents, they are pressurized to withdraw their complaints before any action is taken against the perpetrators (Mlama, 2002). She concludes that the interventions put in place and commitment and persistence on the part of those working on combating the SH in different campuses are helping curb the problem.

Increasing the number and raising the levels of women academics and administrators.

Women in educational management and leadership have been noted to exhibit characteristics such as empathy, consistency, attention to details, honesty, nurturing intuition, sensitivity, caring, supporting, compassion, patience, organization, attention to detail and ability to integrate people, to listen to them and to motivate them through non monetary incentives (Funk, 2004; Cubillo, 1999; Growe & Montgomery, 1999). This is because, according to cultural feminism, women tend to value ideas such as interdependence, co-operation, relationship, community, sharing, joy, trust and peace, while men tend to value ideas such as independence, hierarchy, competition and domination.

Underrepresentation of women in top educational management and leadership positions has had negative implications on government policies and general educational curriculum which has lacked gender mainstreaming. Girl child has also lagged behind in education due to lack of positive female role models (Republic of Kenya, 2007). Republic of Kenya (2007) adds that, the government has put a minimum of 30 percent representation of women in all sectors and particularly in decision making positions, it is foresee that full equality will be eventually achieved as stipulated in international goals, protocols, conventions and the gender policy in education.

1/3 rule faces massive opposition in some spheres of Kenyan society. The authors strongly believe that currently in various circumstances this rule is very ambitious and unachievable, especially in higher administrative positions, due to inherited colonial masters' culture, whose social structure of power was essentially patriarchal. On the other hand, in engineering, this can be rarely achieved since the female engineers can't even make a 1/3 of the total engineers. Therefore constitutional rights in this context cannot be achieved.

The process and outcome of recruitment, scholarships, promotions, etc., for example, should be conducted based, first and foremost, on merit and not on gender; gender should be just a contributing factor and, by no means, a deciding one. The situation, however, is very dynamic and the composition of workforce of Kenya will definitely change alongside with the cultural perception that African man cannot be subordinate to a woman.

Pru Goward, the Australian Sex Discrimination Commissioner at the Human Rights and Equal Opportunity Commission has a straightforward answer to increasing the proportion of women staff and students in traditionally male-disciplines "Promote them. Women succeeding in a profession attract other women". We just would like to make a small addition to that statement, that the promotion should be based solitary on merit.

Confidence and self-esteem building

The Ministry of Higher Education Science and Technology (MoHEST) in collaboration with Women in Science, Technology and Innovation (WOSTI) has organized several workshops under the banner 'National Workshop on Gender Mainstreaming in Science, Technology and Innovation (ST&I)'. These workshops have created awareness, provided an insight to the special roles women play and the problems they encounter in the community and the family that makes it even more important to invest in ST&I.

This strategy contributed to positive impact and many people in tertiary institutions (and in society) are now aware about gender issues and even support gender equity in public, though they may not have acted so in their private lives. An important development in Confidence self-esteem building is the Tool Kit for Mainstreaming Gender in higher education in Africa produced by the Association of African Universities (AAU, 2006). The tool provides nine modules that covers topics such as basic facts about gender, forming policies and strategies, gender sensitization of tertiary institutions, mainstreaming gender in the curriculum, research and gender sensitivity research methods, faculty and support programs, student access and retention, gender violence and sexual harassment, disaggregated data, and resource mobilization for gender equity.

4.2.2.3. *Outreach Programmes*

In SOE, MU the outreach program is the self-initiated marketing activity that has been carried out every year. However due to financial constraints, only limited number of secondary schools in a very small geographical area (close to MU) could be reached. Secondly, the exercise is usually not exclusive to female schools. Nevertheless, it gives the impression to increase the female attraction and therefore admissions to engineering. Verbal reports by the program co-coordinators indicate that probably the students' interest and enthusiasm for engineering has improved. Without any monitoring and evaluation data, it is not possible to say for sure whether or not these outreach programs are increasing enrolments of females in university institutions. The outreach programs should ideally take advantage of alumni, mentors, and work with education and private organizations to bring pre-engineering career exploration and planning to local venues. If possible the programs should also include parents, teachers, and counselors (that help them learn

about engineering as a profession so that they can encourage and support the young people who rely on their knowledge and influence). In addition, authors suggest using a variety of mediums to provide students and their families with stimulating information that describes what engineers do and produce.

4.4.2.3. Boost of Universities enrolment places/capacity

Women's only universities

The launch of Kiriri Women's University of Science and Technology, the only women's university in Kenya, whose main goal is to encourage the enrolment of women in science and technology courses, is a big step towards increasing women's participation in these courses. All the same, women's only universities are controversial. In Kenya, there are those who think that separating women from men throughout their education is unwise as it creates non-natural setting and denies both the opportunity to interact across the genders. Currently the university does not offer any engineering program.

Private Universities

The increased demand for university education has led the government of Kenya to encourage the establishment and accreditation of private universities. By April 2012, there were fourteen (14) chartered private universities that were allowed to offer certificates, diploma and degrees just like public universities (Commission for Higher Education, 2012). At the time of this study there are 17 Private Chartered Universities, 5 Private University Constituent Colleges, 13 Institutions with Letter of Interim Authority and 1 Registered Private Institution with a total enrolment of 35,179 students. For the period between 2000 and 2005, female enrolment in public universities ranges from 34 to 36.7%, whereas in private charted universities it ranges from 54.5 to 56.7% for the same period (Republic of Kenya, 2006). Overall, the situation of female enrolment in accredited private universities is rather different from that of the public universities. Since the 2000/2001 academic year, enrolment of females in private universities has been higher than that of males and reached 53.1% of the total enrolment in the 2005/6 academic year (Republic of Kenya, 2008).

On the other hand, with the exception of some institutions, such as the United States International University (USIU), most private universities in Kenya are religiously-controlled. The majority of these institutions are also limited in capacity with a total student enrolment ranging between 500 in the smallest institutions to 2000 in the largest. The curriculum of most of these institutions is also largely geared towards the arts, business, management and religious courses; similarly, to the women's only university is yet to offer engineering programs.

In the only private university offering science and technology courses - University of Eastern Africa Baraton, Kenya female students enroll mainly in stereotypical courses such as nursing. Consequently, private universities have not contributed much to addressing the problems of female enrolment in engineering subjects and in higher degrees. In addition, private universities are expensive and therefore inaccessible to the poor who are the majority in Africa. In Kenya, however, students in private universities are awarded government loans just like those in the public universities.

Self/privately–sponsored programs

Module II programs – commonly referred to as Self/privately-sponsored programs-or parallel degree programs (PSSP) – whereby, apart from the regular students sponsored by the government, universities are also admitting students who are self-sponsored. These students take their lectures separately in the evening and weekends or as at SOE, MU together with the regular students.

Clearly the programs are increasing the number of women in tertiary institutions. However, as is the case with private universities, the high tuition-fee programs in public universities may deprive many interested and eligible females unless they are given some form of financial support. As an example of SOE, MU government sponsored (regular) students as of 2015 pay tuition-fee of Ksh 39,000 per year, while privately sponsored students pay Ksh 186,500; that gives a difference in tuition-fee of more than 400%.

Flexible time of classes/programs

The introduction of self-sponsored or part-time degree programs in the late 1990s has contributed to women's access to university education, but few females enroll in programs partly because of the high cost and partly because they are offered mainly in universities based in Nairobi, in the evening and weekends. The location and timing of lectures in these programs hinders many women who live and work outside the capital from participating (Onsongo, 2007). These interventions (except for women's only universities) do not exclusively intent for females; yet they have been shown to increase their enrolments. Major challenge in this approach is a limited faculty capacity and some logistics.

Diversification of the methods of delivery

In many Kenyan universities ODL has been realized with different level of implementation and success. The Institute of Open and Distance Learning (IODL), MU, for example, was established in November, 2007 to spearhead the implementation of ODL in the university. The Institute currently has 5 (five) departments through which it provides its services. To date, an e-learning platform-Moi University System of Managing Instruction (MUSOMI) has been installed and has been fully operational. The system is being used for blended learning by over 8000 students and faculty members. Already 446 courses and 39 modules

are unloaded on MUSOMI platform. Considering that teaching and learning at university level must be organized in ways which are more flexible, variable, convenient, cost-effective and geared to the needs of the learner a MUSOMI mobile application for android devices such as Smart Phones and Tablets was developed and implemented to enhance access to the content. Plans are on the way to develop and upload the whole degree program, which probably will take some time, effort, expertise and resources. Analogous to several other interventions discussed, this approach is not designed particularly for females, however especially in case where E-distance learning can be offered, it is a resource with a great potential to attract more students both females and males.

Observations

From the above review of interventions in Kenya on female's enrolment in universities, it is apparent that increasing women's enrolments in university institutions has taken comprehensive, complex and holistic approach. The outcome of such activities, however, should be visibly documented, reported and dissimilated to enable monitoring of the progress in female enrolment in universities.

Despite many years of academic analysis and practical feminist activity, despite prestigious international resolutions and declarations of intent, despite the increased prominence of women's issues in the discourses of governmental and non-governmental organizations alike, progress towards gender equality is still painfully slow.

In addition, a review of literature and research on Kenyan universities reveals that there are no policies or mechanisms in Kenyan universities (public and private) related to the implementation of the proposals made at the UNESCO World Conference on Higher Education to attract more females to STEM education. (Wesonga et al., 2003; Nyamu, 2004; Onsongo, 2002, 2005; Kimani, 2005). The authors propose developing a policy on how to attract more females to engineering education. All stakeholders should participate and contribute to formulation of that policy, in particular representatives from: Ministry of Education, Science and Technology Ministry of Devolution , the department of Gender, and youth affairs, Kenya Innovation Agency (KENIA), ERB and ERBK, Kenya Manufacturers Association (KMA), Universities offering engineering degree programs and Head teachers of Secondary schools as well among others.

A common argument that "when you educate a man you educate an individual and when you educate a woman you educate a nation" basically refers to the high social and economic returns of a woman's education which transcend herself and her family into the wider community by empowering other people. Studies have shown that investing in women's education at all levels contributes significantly to the overall social-economic development through decreased fertility levels, improved nutritional status, child health and education in the family as well as higher labor productivity (Abagi, 1999; Republic of Kenya, 1996; UNDP, 1997). In the view of educating females: Nowadays, use of social media is becoming a domestic necessity, as youngsters spend a lot of time on this type of communication. The media exerts a powerful influence on our attitudes, opinions and choices. In this regard the authors are proposing to establish an "Engineering 101" website that is focused and features on engineering, or to establish and run a blog or online forum where engineering issues as well as gender issues are always addressed through social media such as LinkedIn, Twitter and Facebook among others. This website or blog and open forum will definitely make a difference to the way women and men are depicted in engineering settings by looking at the site with gender in mind. It is not just a matter of including more women more often. It is showing examples (in pictures, video or text) of women from a variety of ethnic and social backgrounds, from a variety of age groups, performing in all areas of engineering, in significant or managerial roles, actively engaged in engineering work that might equally be performed by a man. Successful female-professionals with disabilities should also be included.

Another important issue in encouraging female to pursue engineering is to introduce them to past struggles of females to become accepted as equal to men in engineering profession. As an excellent example legendary Marie Kurri is a very illustrative and important. She had won two Nobel Prizes, one in physics, the other in chemistry, however had seen her application to the Paris Academy (exclusively male at that time) rejected several times. To provide just this example is not sufficient. It is important to have strong and powerful examples of women who are part of the SET community today. There is also need to showcase successful female scientists and engineers and create a culture of mentorship and role-models. Such social media will contribute to identify and connect with diverse audiences and raise awareness of commitment to gender equality. Design and maintenance of such a website definitely will take quite an effort and dedication from the concerned engineering community. This can be done under the umbrella of proposed by Kenya Vision 2030 "Centers of Specialization" for each of Vision 2030's economic growth sectors.

5. Conclusions and recommendations

5.1. Conclusions

In general, this study confirmed that female underrepresentation in engineering is indeed a global phenomenon of great concern. The analysis also illustrate how the underrepresentation of women in SOE

continues to be both progressive (worsening over the course of higher education) and persistent (over time). This study has attempted to show that the problem of female underrepresentation and progression in engineering education is a complex historical, cultural and organisational one for which there is no single solution-no silver bullet- or "quick fix".

Whereas this paper does not – and cannot – explain why gender underrepresentation in engineering education exists, it does aim to provide data and insight that will enable more informed policymaking. The authors foresee that this research will contribute, in its small way, to a nation-wide dialogue on gender equity in engineering that will lead to new public policies, research initiatives, and educational reforms.

This study also tried to give a comprehensive and holistic analysis of various interventions to contribute to the growing body of information on female underrepresentation in engineering education. Virtually all the interventions and initiatives presented here have had a positive impact at local level. The challenge is, however, to develop programmes which are sustainable and scalable across all universities and beyond. Gender research is enormous and multi-faced. Its body of knowledge and understanding is constantly growing like never-ending massive brick-wall consisting of thousands of bricks. The authors strived indeed to add a new brick to that wall of knowledge.

In particular, while MU total admission is steadily increasing, no explicit trend in total enrolment of SOE was established. Analogous, there is no predetermined pattern in female admission for both SOE (13.9% average) and MU (45.4% average), however they both skewed in favor of male. The comparison of female admission trends at SOE with other schools of MU revealed that the persistent underrepresentation of women in engineering is perplexing, particularly when female representation in other programs of MU has enjoyed superior improvement over time. Total retention rate, SOE (2003-2014) was found to be 0.9 (10% drop-outs). 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. Engineering female 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. The situation in SOE is more distinct as the admission ratio of F/M is 0.143, meaning that for every 7 male students admitted to SOE there was only one female student. These trends suggest that females' participation in engineering professions is likely to be affected. This gender imbalance presents a missed opportunity for the diverse engineering workforce, hence systematic intervention into the education system and graduate supply is required.

The data presented in this paper raise serious questions about the future of Kenya's engineering, as the nation needs extra well-prepared and gender-balanced engineering workforce. While current numbers are slightly higher than they were decades ago, in many ways engineering still remains one of the final professional frontiers for women to conquer.

The key for the future of any country and any institution is the capability to develop, retain and attract the best and diverse talent. Women make up one half of the world's human capital. Empowering and educating girls and women and utilizing their talent and leadership fully in the global economy, politics and society are thus fundamental elements of succeeding and prospering in an ever-more competitive world. When compared to other demands of a university, however, diversity and gender generally do not often reach the priority list.

Kenya is striving to achieve the MDG 3 as set out in the UN declaration. To realize this, gender issues should be addressed as articulated in the broad national and university strategies which include among others; the Kenya Vision 2030, the National Strategy for University Education, 2007-2015, The National Gender policy, and the Moi University Strategic Plan 2009/2010-2014/2015 among others. And the sooner we jointly, appropriately and effectively deal with female underrepresentation in engineering education the better!

Recommendations

Practical suggestions on what actions in a tertiary institution can be done and a detailed discussion on how a tertiary institution can go about programming for gender equity can be found in FAWE (1998), Bunyi (2003) and Lewis (2000) among others. Specific recommendations of this study are as follows:

1) Government Policy on how to attract more females to STEM and particularly to engineering should be developed by all the appropriate stakeholders.
2) The authors are proposing to establish an "Engineering 101" website that is focused and features on engineering, or to establish and run a blog or online-forum where engineering issues as well as gender issues are always addressed through social media such as LinkedIn, Twitter and Facebook among others.
3) The shortage of reliable research data on interventions to increase female enrolment is a big problem in assessing progress, therefore more research should be carried out, and not only by Gender Centers or Institutes, but also in collaboration with chronically affected by female underrepresentation schools, such as for example SOE, MU, where for example their own tailored programs will be developed for i**n**creasing the enrolment of female students.

4) The universities should initiate through the Gender centers Mentorship programs for female students in the SET.
5) The IEK and EBK should put in place structures and set aside budget to facilitate redress of Gender imbalance in Engineering. It would be logical and appropriate for these organizations to consider and take organizational responsibility for timely consideration of our proposal on "Engineering 101" website, blog or forum.
6) This study was based on only one university. To get a more comprehensive view, however, it would be interesting to evaluate female representation in other Kenyan universities, offering engineering programs.
7) Although women's underrepresentation in engineering education may be quantified, its precise causes are less easily grasped. Such an understanding is essential. Therefore further study should be conducted to identify the root-causes of female underrepresentation in engineering education, starting probably with secondary schools, where pre-university carrier choices are made.
8) Further studies should be carried out to examine and mitigate the high rate (10%) of female students' dropouts in SOE, MU.
9) Ultimately, it is vital to monitor progress. Therefore more initiatives which ensure the collection of complete and accurate statistics, both quantitative and qualitative, are essential.

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