Academic Staff in Engineering and the Built Environment at Durban University of Technology: A Baseline Study of Gender Equality

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ABSTRACT

The research reported in this paper is part of a large Personalised Engineering Education South Africa III Project that involves eight universities across Europe and South Africa. One of the foci of the project is around gender equality in engineering education. The literature on Women in Science, Engineering and Technology (STEM) in general is briefly reviewed. Attention then shifts to gender equality in STEM, academia, and engineering education more specifically. Management Information data from 2014 to 2018 were analysed to establish a baseline for the number and the rank of female staff in seven academic departments in the Faculty of Engineering and the Built Environment (EBE) at Durban University of Technology (DUT). The results show that there is low representation of female staff in the selected academic departments. Female staff are not represented in the higher academic ranks such as Associate or Full Professors. These findings resonate with other published research. This baseline study will be used to further investigate the experiences of women in EBE at DUT.

Keywords: Gender equality, Engineering Education, Universities of Technology, South Africa.

INTRODUCTION

The European Union funded Personalised Engineering Education in Southern Africa (PEESA) III project involves eight universities in Europe and South Africa. One of the foci of the project is around gender equality in engineering education. The specific goals are to increase both: the number of female academic staff members in the PEESA III project meetings; and the enrolment of female engineering students in the partner universities in Southern Africa.

In recent years significant changes have been made to equity legislation, accompanied by economic incentives for women to transfer into historically male-dominated occupations. However, women who defy conventional female career paths by choosing to pursue careers in male-dominated occupations, often return to careers that accommodate their roles as primary caregivers (Ashraf, 2007; Cha, 2013; Danziger & Eden, 2007; England, 2010; Frome, Alfeld, Eccles & Barber, 2006). The challenges experienced by women arise from traditional gender hierarchies prevalent in societies, which spill
over into organisational policies and practices and ultimately become embedded in gender-biased organisational culture, structure and management strategies. As a result organisations do not necessarily support the career paths of women and the efficient integration of work with family responsibilities (Bobbitt-Zeher, 2011; Cha, 2013; Frome et al., 2006).

In South Africa transformation has positively impacted women, with an increase in the number of women in the workforce due to improved access to education, the promulgation of equity legislation, and increased employment opportunities in previously male dominated environments (Finnemore & Cunningham, 1995; Franks, Schurink & Fourie, 2006; Mostert, 2009; Van den Berg & Van Zyl, 2008). However, progress with gender equality and transformation in academic sciences and the workplace is still deemed to be unsatisfactory (Anonymous, 2012; Du Plessis & Barkhuizen, 2012; Hicks, 2012; Lewis-Enright, Crafford & Crous, 2009).

Previous studies on gender based issues in organisations in South Africa have identified pre-defined phenomena that specifically affect woman in the workforce. These include, the life-role construction of career-orientated women; the work-home interaction; cross-cultural comparisons of stress in high-level career women; perceptions on gender differences in workplace progression; the barriers affecting women in their careers in engineering, and issues of gender and race for South African quantity surveyors in the workplace (Brink & De la Rey, 2001; Mostert, 2009; Van Aarde & Mostert, 2008; Franks et al., 2006; Van Den Berg & Van Zyl, 2008; Du Plessis & Barkhuizen, 2012).

The Women in Engineering Research Team at DUT has adopted a comprehensive approach to exploring the project goals for an increase in the number of both female academic staff and the enrolment of female students. The team developed a proposal for a case study, grounded in two baseline studies, followed by a qualitative study of the issues and challenges facing female staff and students in seven selected departments in the Faculty of Engineering and the Built Environment (EBE). The first baseline study, on gender equality among female students in either engineering or construction management at DUT, was conducted in 2018. This study revealed that whilst female students were underrepresented in these fields they consistently performed better than their male counterparts in terms of pass rate, attrition rate and throughput rate. When the data were disaggregated a spectrum of representation by enrolment in the seven engineering programmes was revealed which ranged from just over 10% of females for Mechanical Engineering to almost 50% for Chemical Engineering (Cooke, Jackson and Hefer, 2018).

This paper focuses on the representation of female staff in seven academic departments in EBE: Civil Engineering (Durban); Civil Engineering (Midlands); Chemical Engineering; Industrial Engineering; Mechanical Engineering, Electronic and Computer Engineering, and Construction Management and Quantity Surveying. The context is set through a brief literature review of: the global picture of women in science, technology, engineering and mathematics (STEM), gender equality in academia; and women in engineering education. The focus then moves to an analysis of the number of women in engineering, and construction management at DUT. The paper concludes by identifying some of the challenges facing women in engineering education and elucidates the next phase of the research project at DUT.

WOMEN IN STEM: THE GLOBAL PICTURE

The lack of public recognition for the work of brilliant female scientific minds can be traced back through over a hundred years of history. For example, Patricia Fara (2018) writes about the huge impact that women had in the First World War (1914 -1918). As men left to fight in the War women scientists took over their vacated positions and engaged in warfare related research When the War was over and the men returned, the women were forced to revert to the same low status positions that they had held prior to the War. So for female scientists, doctors and engineers the opportunities post-war were lost. Today the inequalities in the number of male and female scientists, especially at higher levels, still persist (Fara 2018).
STEM fields are broadly regarded as essential to the national economy of any country. However, as indicated above, globally, women continue to remain under-represented in professional occupations that are associated with STEM. The past two decades have seen policy makers and researchers focus on challenges to the recruitment, retention and social equity of women in STEM at higher education institutes (Blair-Loy, Rogers, Glaser, Wong, Abraham, and Cosman, 2017). Studies have reflected that inherent biases, in for example the assessment of professional competence, disadvantage women, while giving men credit for high levels of competence (Ridgeway, 2011; Williams and Dempsey, 2018). These assumptions that highlight women as being less competent, are often found in male-dominated STEM professions (Carli, 2001; Ridgeway and Smith-Lovin, 1999).

Likewise the field of engineering and construction has historically been seen as a male dominated profession due to the culture and attitude of the industry (Evets, J. 1998; and Barnard, Bagilhole, Dainty and Hassan, 2012; and Powell, Bagilhole, and Dainty, 2009). In the Anglo world there is a lack of women in engineering and technology, for example 11% of the workforce in the US, 10.5% in Canada and 8.5% in the UK are women. Whilst the gender disparity in the engineering workforce in some European countries may be healthier (25% in Bulgaria, Croatia and Romania), less than 15% of the engineering workforce in Switzerland, Austria, Finland and Ireland are women (Hutchins & Kovach, 2019). In Australia women are underrepresented in STEM at school and engineering programmes at university. Women comprise less than 10% of the engineering workforce and this imbalance is mirrored in the workforce of academic engineers at universities (Dobson, 2012).

GENDER EQUALITY IN ACADEMIA, STEM, AND ENGINEERING EDUCATION

Gender equality in academia can be defined in several ways. The first is where equity is equated with equality through equal pay, equal access to opportunities to enter an occupation and advance in it, career advancement and freedom from harassment. However, equality is still not the same as equity – equating equity with equality makes an assumption that the workplace is completely separated from the rest of life. Through being gender-neutral this first definition ignores the different life experiences of men and women and makes the current ‘male’ model of the ideal academic normative. It makes assumptions that women can follow the model as easily as men and be seen as successful and as central as their male colleagues. This leads to a second definition that goes beyond equal opportunities, and that is based on practices that promote fairness and that take an academic’s life outside the academy into consideration. Whilst this second definition allows for practices such as parental leave it does not take into consideration the career consequences for women who take advantage of the leave (Bailyn, 2003).

Bailyn (2003) proposes that the ideal definition of gender equality is be based on the integration of the public sphere of work and the private sphere of family, community and other personal involvements. For true integration to occur organizational practices, culture and rules need to be scrutinized, modified accordingly and understood by everyone. Bailyn documented the experiences of female academics at Massachusetts Institute of Technology in 2003. Some nine years later Dobson (2012) indicated that whilst the proportion of female academics in general is rising, it is at a slow rate. He also indicated that women are more likely to be in junior positions (lecturer), younger than their male counterparts, and less likely to be tenured.

Over the past 25 years, the role and rank of women in the field of STEM has been a vital concern that is rooted in two essential sets of issues: the recruitment of females; and the social equity of professional female participation. Several authors have written about the status of women in STEM, and whilst some studies have suggested that the playing field of progression between men and women is level, however, others have presented opposing views. The only widely-agreed-upon conclusion is that women are underrepresented in professional fields such as geoscience, engineering, economics, mathematics, computer science, and the physical sciences (Ceci, Ginther, Kahn, and Williams, 2014). In Europe for example, although there have been sustained efforts to promote engineering careers to
young women, engineering is still the most male-dominated academic discipline (Barnard, Bagilhole, Dainty, and Hassan, 2012).

Hutchins and Kovach (2019) identify that the issue of the low representation of women (and women of colour) as academics in STEM constrains universities from being truly diverse and inclusive and that this limits the development and enhancement of women scientists. Furthermore, for women in engineering at higher education (HE) institutions, the challenge of breaking through the barrier of historically male dominated occupations, accompanied by the unwillingness to accommodate them in those occupations, provides for an unattractive workplace environment. A further lack of understanding of the challenges faced by women and the manner in which they cope in these environments may contribute to the poor integration and advancement of women in the field of engineering (Fox, 2001; Martin, & Barnard, 2013).

It is well-documented that women are underrepresented in advanced positions in HE in Europe. In most European countries there are more women undergraduates than men, and more women graduate than men. However, the unequal gender structure of higher positions (senior lecturers and professors) persists in that, in general, men hold more top positions in HE than women, especially at the level of professor (Silander, Haake and Lindberg, 2013). In HE in the UK, the lack of women in senior positions in STEM, in particular at the professorial level (12%), is well recognized (Howe-Walsh and Turnbull, 2016). Likewise in the USA although there are more female academics than ever before (40.5% of all fulltime positions), the gains in all fields has not been equal, such that engineering, with 11.5%, has the lowest proportion of female academics. Women academics in all disciplines are in the lowest ranked positions. Female engineering academics are concentrated at the rank of assistant professor and very few become full professors. Although 23.6% of all full professors are women, only 2.8% of all engineering full professors are women (Minerick, Wasburn and Young, 2009).

Furthermore, women in academia often engage in very different career paths in comparison to their male counterparts, have less continuity in their Curriculum Vitae, and experience more stress and greater isolation (Meschitti and Smith, 2017). Whilst the barriers to female leadership in academia broadly have been reported, less attention has been focused on the experiences of women in STEM with the consequence that less is known about the challenges for females assuming leadership roles within these fields (Howe-Walsh and Turnbull, 2016).

WOMEN IN ENGINEERING EDUCATION AT DUT

Management Information (MI) data were analysed in order to establish the number of staff by gender in the seven academic departments of Civil Engineering (Durban); Civil Engineering (Midlands); Chemical Engineering; Industrial Engineering; Mechanical Engineering, Electronic and Computer Engineering, and Construction Management and Quantity Surveying in EBE at DUT. Data were gathered on the headcount of permanent academic staff by gender, headcount of secretaries and laboratory staff by gender, and the gender distribution of academic staff by rank, in the seven academic departments. The data, across a five year time period from 2014 to 2018, are presented in Table 1 - 4, and Figures 1 - 3 below.
Table 1 presents the headcount of permanent academic staff by gender in the seven academic departments for 2014 to 2018. The data show that, in 2014 the number of female academic staff in each of the seven departments was low in general and very low in Civil Engineering and Geomatics, Electronic Engineering and Mechanical Engineering. The overall representation of females had shown little to no improvement by 2018. In the case of Mechanical Engineering there was negative growth (1 female in 17 staff in 2017 and 0 females in 14 staff in 2018).

Table 1: Headcount of Permanent Academic Staff by Gender for 2014 to 2018 in 7 departments in EBE

| Department                      | 2014 | 2015 | 2016 | 2017 | 2018 |
|---------------------------------|------|------|------|------|------|
|                                 | Female| Male | Female| Male | Female| Male | Female| Male | Female| Male |
| Chemical Engineering            | 3    | 4    | 3    | 7    | 3    | 7   | 3    | 8    | 3    | 9    |
| Civil Eng & Geomatics           | 1    | 17   | 1    | 17   | 1    | 18  | 2    | 17   | 2    | 17   |
| Civil Eng (Midlands)            | 3    | 6    | 1    | 6    | 3    | 6   | 3    | 6    | 3    | 6    |
| Const Mngt & Quant surveying    | 2    | 5    | 2    | 6    | 2    | 5   | 2    | 6    | 4    | 6    |
| Electronic Engineering          | 1    | 20   | 1    | 20   | 1    | 19  | 1    | 19   | 2    | 19   |
| Industrial Engineering          | 1    | 5    | 1    | 5    | 1    | 5   | 1    | 5    | 1    | 5    |
| Mechanical Engineering          | 1    | 16   | 0    | 15   | 0    | 16  | 0    | 14   | 0    | 14   |
| **Total**                       | 12   | 73   | 9    | 76   | 11   | 76  | 12   | 74   | 15   | 77   |

The lack of representation of females in the total headcount of permanent academic staff is even more evident when the data are presented as a percentage in Table 2. The data clearly indicate that male staff dominate in each of the seven departments. The number of female academic staff has very marginally increased from 12 (14%) to 15 (16%) in the time period from 2014 to 2018.

Table 2: Percentage of Female Academic Staff: 2014 & 2018 in 7 departments in EBE

| Department                      | 2014 | 2015 | 2016 | 2018 |
|---------------------------------|------|------|------|------|
|                                 | Female| Male | Female %| Female| Male | Female %|
| Chemical Engineering            | 3    | 4    | 43%   | 3    | 9    | 25%    |
| Civil Eng & Geomatics           | 1    | 17   | 6%    | 2    | 17   | 11%    |
| Civil Engineering (Midlands)    | 3    | 6    | 33%   | 3    | 6    | 33%    |
| Const Mngt & Quant Surveying    | 2    | 5    | 29%   | 4    | 6    | 40%    |
| Electronic Engineering          | 1    | 20   | 5%    | 2    | 19   | 10%    |
| Industrial Engineering          | 1    | 5    | 17%   | 1    | 6    | 14%    |
| Mechanical Engineering          | 1    | 16   | 6%    | 0    | 14   | 0%     |
| **Total**                       | 12   | 73   | 14%   | 15   | 77   | 16%    |

The data on the headcount and percentages of total of secretaries and laboratory staff by gender in Tables 3 and 4 reveal a similar trend in terms of representation of females. The situation is comparable to that with female academic staff; a number of departments have only one female member of staff in the secretaries and laboratory staff sector. Notably each of the seven departments has a female secretary (in five of the departments this accounts for the ‘1’ female captured in the table) and the number of female non-academic staff has decreased from 9 (24%) in 2014 to 8 (21%) in 2018.

Table 3: Headcount of Secretaries and Laboratory Staff by Gender: 2014 to 2018 in 7 departments in EBE

| Department                      | 2014 | 2015 | 2016 | 2017 | 2018 |
|---------------------------------|------|------|------|------|------|
|                                 | Female| Male | Female| Male | Female| Male | Female| Male | Female| Male |
| Chemical Engineering            | 2    | 5    | 2    | 5    | 2    | 5   | 2    | 4    | 2    | 4    |
| Civil Eng & Geomatics           | 1    | 5    | 1    | 5    | 1    | 4   | 1    | 5    | 1    | 5    |
| Civil Engineering (Midlands)    | 1    | 3    | 1    | 4    | 1    | 4   | 1    | 4    | 1    | 4    |
| Const Mngt & Q Surveying        | 1    | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    | 1    |
| Electronic Engineering          | 2    | 8    | 1    | 7    | 1    | 8   | 1    | 9    | 1    | 9    |
| Industrial Engineering          | 1    | 1    | 1    | 1    | 1    | 1   | 1    | 1    | 1    | 1    |
| Mechanical Engineering          | 1    | 5    | 1    | 6    | 1    | 6   | 1    | 6    | 1    | 6    |
| **Total**                       | 9    | 28   | 8    | 29   | 8    | 29  | 8    | 30   | 8    | 30   |
Table 4: Percentage of Female Secretaries and Laboratory Staff: 2014 to 2018 in 7 departments in EBE

| Department                        | 2014 |            | 2018 |            |
|-----------------------------------|------|------------|------|------------|
|                                   | Female | Male | Female % | Male | Female % |
| Chemical Engineering              | 2     | 5     | 29%     | 2    | 4     | 33%     |
| Civil Eng & Geomatics             | 1     | 5     | 17%     | 1    | 5     | 17%     |
| Civil Engineering (Midlands)      | 1     | 3     | 25%     | 1    | 4     | 20%     |
| Const Mngt & Quant Surveying      | 1     | 1     | 50%     | 1    | 1     | 50%     |
| Electronic Engineering            | 2     | 8     | 20%     | 1    | 9     | 10%     |
| Industrial Engineering            | 1     | 1     | 50%     | 1    | 1     | 50%     |
| Mechanical Engineering            | 1     | 5     | 17%     | 1    | 6     | 14%     |
| **Total**                         | **9** | **28** | **24%** | **8** | **30** | **21%** |

Figures 1 and 2 present the total number of female academic staff plus the total number of secretaries and laboratory staff as a percentage on the total staff for 2014 and 2018 respectively. The pie charts for both years illustrate at a glance the low representation of females across the five-year period and the lack of improvement during this time span in the seven departments.

Figure 3 shows the stark picture regarding the distribution of female staff according to rank in the seven departments. In 2014 the majority of the small number of female staff held the rank of Lecturer. The females were clearly ranked in lower positions than their male counterparts. By 2018 the situation had barely changed with only a very marginal increase in the ranks of female Lecturers and Senior Lecturers. There are no female associate professors or full professors in the seven departments.
The data for the seven departments in EBE pertaining to the representation and rank of female staff resonates strongly with the findings in the literature presented earlier. Representation of female staff in general is low, and female academic staff are employed at the lower levels of rank than males. Furthermore, the situation has clearly not improved over a five year period. These findings resonate with the 2018 baseline study which revealed less than 30% of female students were registered in Civil, Electrical and Mechanical Engineering (Cooke, Jackson and Hefer, 2018).

CONCLUSIONS AND FURTHER RESEARCH

The baseline study data for the representation of female staff, and the ranks of female academic staff in EBE at DUT over a five-year period are presented. The findings are consistent with those presented in the relevant literature. Females are underrepresented in both academic and support staff; the rank of female academic staff is lower than their male counterparts; there are no female associate or full professors in the seven departments in EBE.

Women academics in STEM face many issues and challenges relating to their gender, including: institutional processes for recruitment and selection; discrimination of female candidates with a family; perceptions that females are less competent than, and have lower publication outputs and research funding than their male counterparts; lack of endorsement from peers for promotion to senior levels; and the absence of female role models in leadership positions (Howe-Walsh and Turnbull, 2016). At DUT these issues and challenges will be explored through further research in a qualitative study, conducted from a constructivist grounded theory perspective. Data will be gathered from a range of sources to investigate the research questions pertaining to engineering and built environment programmes. The questions include: factors influencing the choice of career; experiences of studying/working; the main challenges encountered; initiatives that DUT can implement; the main contributing factors to the students'/staff development; the overall differences between the experience of male and female students/staff; the recommendations female students/staff would make to new female students/staff.

The overall findings (baseline and qualitative studies) will assist EBE with the development and implementation of policies, strategies and initiatives structured towards attracting, integrating, retaining, supporting and motivating women students and staff, in engineering and the built environment education. The study aims to contribute towards understanding the manner in which integration of women in academia may successfully occur. Furthermore, the study will inform the strategy that EBE will adopt to achieve gender equality.
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