International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 01
January 2018

Factors Affecting Academic Performance of Women in Engineering Education and Their Experience of Participation in Employment: Literature Review

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Abstract:

Engineering education is the base for overall development and poverty reduction. The problem is there is higher gender disparity in the filed in most of the countries. As studies shows that Women are underrepresented both in STEM jobs and STEM undergraduate degrees and have been consistently over the last decade due to many factors that affects their academic performance in engineering education that leads to being underrepresented in employment also. Although the involvement of women in engineering is increasing, they are still viewed as a minority in the field. The purpose of this paper is t factors that affect academic performance of women in engineering education and their experience of employment by reviewing previous research works. There are many factors that affecting academic performance of women in engineering education which contributes low performance than their counterpart that leads to women being underrepresented in engineering employment.

Keywords: Women, Engineers Education, Academic Performance, Employment, Literature Review

1. Introduction

There has been considerable effort in the last decade to increase the participation of women in engineering through various policies. However, there has been little empirical research on gender disparities in engineering which help underpin the effective preparation, co-ordination, and implementation of the science and technology (S&T) policies [5]
Despite growing diversity among life sciences professionals, members of historically un-derrepresented groups (e.g., women) continue to encounter barriers to academic and career advancement, such as subtle messages and stereotypes that signal low value for women, and fewer opportunities for quality mentoring relationships. These barriers reinforce the stereotype that women's gender is incompatible with their science, technology, engineering, and mathematics (STEM) field, and can interfere with their sense of belonging and self-efficacy within STEM [17]. Research on the "Psycho-social Determinants of Gender Prejudice in Science, Technology, Engineering and Mathematics (STEM)"show that females were found to be underrepresented in STEM fields. This under-representation results from gender stereotype, differences in spatial skills, hierarchical and territorial segregations and discrimination on job allocation [12].

Comparison of data from various sources makes it clear that the enrolment of women in Engineering in India is far below what it should be. Some of the underlying factors that may be responsible for the lack of interest amongst women towards engineering are Lack of Inspiring Role Models, Lack of appropriate infrastructure, design of products, and facilities for women, Lack of organizational flexibility (location, time) to encourage and motivate women to work (and continue to work) and Lack of women's involvement in decision making processes [18]. Despite sustained efforts to promote engineering careers to young women, it remains the most male dominated academic discipline in Europe [14].

Engineering is commonly assumed to be a male-dominated profession. Despite this, the number of women enrolling as engineering majors and practicing in the engineering profession has been rising. Although the involvement of women in engineering is increasing, they are still viewed as a minority in the field. In general, the proportion of women employed in technology-related fields is much lower than the proportion participating in the general workforce (2007). In the UK, for example, the 2006 Skills Survey examined the skills of 4800 working individuals aged 20–65 and compared them

with those from similar surveys undertaken over the last two decades provided an analysis of gender differences in relation to skills, including skills trends, qualification requirements, the value of skills, task discretion, and attitudes towards work and skill development [7].

Women are underrepresented both in STEM jobs and STEM undergraduate degrees and have been consistently over the last decade. The relatively few women who receive STEM degrees are concentrated in physical and life sciences, in contrast to men, who are concentrated primarily in engineering. Women who do receive STEM degrees are less likely to work in STEM jobs than their male counterparts. And while women working in STEM jobs earn less than their male counterparts, they experience a smaller gender wage gap compared to others in non-STEM occupa- tion. The underrepresentation of women in STEM majors and jobs may be attributable to a variety of factors. These may include different choices men and women typically make in response to incentives in STEM education and STEM employment for example, STEM career paths may be Less accommodating to people cycling in and out of the work-force to raise a family or it may be because there are relatively few female STEM role models. Per-haps strong gender stereotypes discourage women from pursuing STEM education and STEM jobs [4]

Gender differences in science and engineering have been studied in various countries. Most of these studies find that women are underrepresented in the S&E workforce and publish less than their male peers. The factors that contribute to gender differences in experience and performance in S&E careers can vary from one country to another, yet they remain underexplored Women make up 47% of the total U.S. workforce, but are less represented in engineering, computer sciences, and the physical sciences. In addition, race and ethnicity are salient factors and minority women comprise fewer than 1 in 10 scientist or engineer [8].
The proportion of women in the engineering workplace has followed this increasing trend, which shows that female students have been able to find employment after achieving their degrees. Despite the gains in gender equality, however, it is apparent that ambivalence still surrounds `the woman engineer' today. The proportion of women is high in some programmes and very low in others. The career paths of women and men who are engineers are not comparable either. Moreover, a cultural contradiction between being a woman and being an engineer is mirrored in every-day language, where women are depicted as `soft' while technology is described as `hard' [10].

2. Methodology

This review of research is empirical review. The study reviews perilous research's done by researchers related to factors affecting academic performance of women in engineering and science education as well as status of their participation of employment in Engineering filed which is published in different Journals including European Journal of Engineering Education. The method of analysis in this review is based on identifying which method, how many sample were taken, how sample is taken, from which population and from which country were collected and what is their finding and conclusion which invites to identify the factors that retards women in engineering and science education that can create disparity in performance and employment participation to and give recommendation for the concerned stakeholders to reduce the problem.

3. Literature Review

[16]Investigate comparative study of factors affecting between male and female engineering students by taking data from 89 female and male students through interview and questionnaire. The finding shows that even if there are many identities between female and male engineering students female are more disadvantages that declines female's probability of success in this area of discipline.

[3] Examine 2000 students who enrolled in challenge-based engineering course in Texas, females constituted a clear minority, comprising only a total of 14% of students. Quantitative analyses of surveys administered at the beginning of the school year 2011 revealed that there is statistically significant gender gaps in personal attitudes towards engineering and perceptions of engineering climate. Researcher found that compared to males, females reported lower interest in and intrinsic value for engineering, and expressed less confidence in their engineering skills. Additionally, female students felt that the classroom was less inclusive and viewed engineering occupations as less progressive.

[17] investigate Psychosocial Pathways to STEM Engagement among Graduate Students in the Life Sciences. The purpose of this study was 1) focusing on a distinct period in women's careers that has been relatively understudied, but represents a critical period when career decisions are made, that is, graduate school; and 2) highlighting the buffering effect of one critical mechanism against barriers to STEM persistence, that is, perceived support from

advisors. Data for this study were collected in the context of a larger, longitudinal study of graduate students in STEM fields in US citizen. 332 doctoral students in social science and STEM programs completed the online survey. 205 of those students were enrolled in doctoral programs in STEM, and 102 of those students were enrolled in doctoral programs in the biological sciences. 49.3% of sample was female. The sample was cross-sectional and assessed using a scale of 1 (strongly disagree) to 7 (strongly agree). Results of this study show that perceived support from one's advisor may promote STEM engagement among women by predicting greater gender STEM identity compatibility, which in turn predicts greater STEM importance among women (but not men). STEM importance further predicts higher sense of belonging in STEM for both men and women and increased STEM self-efficacy for women.

[21] studied Factors Affecting Female Students' Academic Achievement at Bahir Dar University by using data collected from 200 male and 400 female students studding in 6 faculty including engineering through questionnaire, document analysis, observation and interview which is analyzed by the help of descriptive analysis and linear regression. The finding shows that high school academic background is the main factor for their low academic performance. In addition personal factor and university environment are also contribute for their low performance.

[13] Investigate inequality of higher education of Ethiopia regarding to science, Technology, engineering and mathematics education by taking data from sample of 380 respondents who study in social science and natural science students, head of gender office and lecturers from Addis Ababa University and Adama University through interview, questionnaire and document analysis data collection techniques. Data were analyzed by using mixed methods. The finding shows that female students are highly underrepresented in the science filed of higher education of Ethiopia due to various factors.

[11] Investigation in women experience of higher education in Ethiopia by taking qualitative data from 2 government universities in the year 2010 through focus group discussion which is grouped in to 4 and each group contains 5 respondents of women student and academic members to understand gender inequality at higher education. The finding shows that sexual violence and prejudice contrary to women are indicator of inequality in the university.

[6] A study on factors affecting academic performance and competency of female students in Ethiopia by collecting data from 135 female students at Dire Dawa University through questionnaire and interview founds that institutional related factors, family and background related factors, environmental and socio-cultural factors, student's behavior and commitment related factors were major themes of female students' poor academic performance and Competency.

[22] A study on Self-Restrain or Discrimination - Participation of Women Engineers in India. Secondary data analysis from the year 1950- 2011 and 11case study were conducted by the researcher to investigate women enrolment in engineering and employment participation of women engineers in India. The finding concludes that women in growing numbers are joining engineering in India and making significant dent but even then, it is at the lower side when compared with other disciplines of education as science, medical and arts. Even after joining in to the labour market, their number decreases. The reasons is lower participation of women in engineering education before liberalization as well as child bearing and rearing age.

[1] Investigation on Returning to STEM: gendered factors affecting employability for mature women students. Data in this paper are drawn from longitudinal study of 167 women graduates in science, technology or mathematics in 2011 and 2012, through a postal survey who participated in a UK government-funded online programme aimed at supporting them to return to work. Twenty-three of the 66 respondents were then interviewed by telephone. The interview transcripts were analyzed using a coding scheme adapted from McQuaid and Lindsay's Employability framework (2005) with the aim of identifying individual, personal and external factors that had contributed to career outcomes since completing the course. The paper examines three gendered factors identified as being of particular influence on outcomes gender role normativity, locality and mobility, and structural and institutional barriers. The researcher argued that employment in science, engineering and technology are male-dominated sectors. This is not limited to young first-time graduates but continues and evolves throughout the life course. Mature women students, who are returning after career breaks, face a number of barriers in re-entering such employment sectors

[4] Investigation on the Compliance of Women Engineers with a Gendered Scientific System. This article aims to present a comprehensive gendered analysis of engineering publications across different specialties and provide a cross-gender analysis of research output and scientific impact of engineering researchers in the academic, governmental, and industrial sectors. The research focus is specifically on the peer-reviewed articles published in the

journals listed under the 'Engineering and Technology' discipline by the U.S. National Science Foundation's (NSF) Science and Engineering (S&E) classification scheme which is categorized into 13 sub fields . For this purpose, 679,338 engineering articles published from 2008 to 2013 are extracted from the Web of Science database and 974,837 authorships are analyze. The quantitative analysis of this research is grounded on bibliometric indicators of scientific production. Bibliometrics is a quantitative method used to measure scientific activity through the analysis of the scientific publications and of their metadata. The structures of co-authorship collaboration networks in different engineering disciplines are examined, highlighting the role of female scientists in the diffusion of knowledge. The findings reveal that men dominate 80% of all the scientific production in engineering. Women engineers publish their papers in journals with higher Impact Factors than their male peers, but their work receives lower recognition (fewer citations) from the scientific community. Engineers regardless of their gender contribute to the reproduction of the male-dominated scientific structures through forming and repeating their collaborations predominantly with men.

[2] examine gender discrimination in the employment and earnings of engineering graduates in India by collecting data from 1178 both female and male 4th year students in the year 2009-2010 in Delhi in four state of India in 11 engineering institutions of 5 government and 6 private owned institutions. Data were analyzed by the help of logit and OLS models. The finding shows that there is smaller percentage of women engineering graduates than men have got job and offered earnings of women are about 54% less than that of men.

[23] studied the labor supply of women in STEM, The purpose of this paper is to assess the determinants of female labour supply in science, technology, engineering and mathematics (STEM). The author forms 72 groups for every survey year. The estimates include 216 groups after the application of the classification to a pooled data set of three survey years (2007, 2008, and 2009) and estimated by using a control function approach .A Heckman selection model2 is applied to regress labour participation on a complete set of time and group interactions and demographic variables. The participation equation is estimated for the whole sample. Non-working women are excluded from the estimation sample of log wages and non-wife income. Ordinary least squares (OLS) regression were also used. For the analysis, the cross sectional data sets of the year 2007, 2008 and 2009 are taken. The data set comprises approximately 205,000 individuals. For a comparison of labour market behaviour between women in STEM and other occupations, the dummy variable STEM is introduced that equals 1 if a women works or has worked in the fields of science, technology, engineering, and mathematics. The author finds that women, especially mothers, in STEM work more hours, but have a higher probability of being out of the labour force. The estimation results show that women in STEM work less hours in countries with higher levels of family allowances. However, this effect is small in size compared to the overall effects of larger levels of expenditures on family allowance and child benefits.

[9] Investigation on I still want to be an engineer! Women, education and the engineering profession by using data sources from three-fold: depth interviews with 51 engineers, electronic survey of three large engineering from 357 firms and interviews and focus groups across the three firms of 115 respondents in Australia women and man engineers. The data were analyzed using the NVIVO software package. The result from data of Australian women engineers shows that the relevance of success in math and science at school to their enrolling in engineering at university. However, for a significant number of the women the positive self-image connected with school success was not maintained by their workplace experience. Investigations of the attitudes and experiences of working engineers at three large firms suggest that engineering workplaces continue to be uneasy environments for professional women.

[14] Study on Arab Women in Science, Technology, Engineering and Mathematics Fields. Data of women enrolment in STEM and percentage of employment were taken from UNISCO and World Bank for 10 countries and Arab Stats and analyzed using percentages. The finding shows that in most countries of the world, 40 to 50 % of students are women. However, there is greater sex imbalance in STEM fields. Indicators show that tertiary education in Arab region is high compared with gender balance in several countries; there is even imbalance in favor of women as in Saudi Arabia & Gulf States. UNESCO and World Bank statistics reveal that Arab women actively pursuing STEM fields e.g. in 2014, women comprises 59% of total students enrolled in computer Science in Saudi Arabia while UK and USA women enrolment were 16% and 14% respectively. Graduate women attempt to pursue career or postgraduate degrees are often excluded on bases of their gender and marginalized therefore much less to enter and remain in the job. In principle, there are equal opportunities for both genders in many Arab States, but social perception and prejudice determine which types of employment are particularly suitable for women or men.

International Journal of Research
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Volume 05 Issue 01
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[20] Findings from negative binomial regressions show that women publish less than their male counterparts in science but not in engineering in the U.S. In China, women do not differ from men in publication productivity in science but publish more than their male counterparts in engineering. In addition, some background variables affect men's and women's publication productivity differently.

[19] A study on engineering graduates in Ethiopia have had a good employment status in the five years of the study, with an average employment rate of 80.3 percent. However, an increasing trend of graduate unemployment is observed. Substantial variations are observed among graduates of the various engineering disciplines and between men and women: civil engineers have better employment prospects, and the employment status of women is consistently lower. The findings also indicate that the education– job mismatch is both vertical and horizontal, and affects more than a third of the graduates (41.5 percent).

Table 1 Summary of Literature Review of factors affecting academic performance of women in engineering Education.

Author	Their Finding
S.J, Dench (1990)	The finding shows that even if there are many identities between female and male engineering students female are more disadvantages that declines female's probability of success in this area of discipline.
C. Riegle-Crumb, C. Moore (2013)	Researcher found that compared to males, females reported lower interest in and intrinsic value for engineering, and expressed less confidence in their engineering skills.
S. L. Clark et al. (2016)	Results of this study show that perceived support from one's advisor may promote STEM engagement among women by predicting greater gender STEM identity compatibility, which in turn predicts greater STEM importance among and increased STEM self-efficacy for women.
Yeshimebrat Mersha et al. (2013)	The finding shows that high school academic background is the main factor for their low academic performance. In addition personal factor and university environment are also contribute for their low performance.
Robsan Margo Egne (2014)	The finding shows that female students are highly underrepresented in the science filed of higher education of Ethiopia due to various factors.
Molla and Cuthbert (2014)	The finding shows that sexual violence and prejudice contrary to women are indicator of inequality in the university.
H. Mamo et al. (2017)	Founds that institutional related factors, family and background related factors, environmental and socio-cultural factors, student's behavior and commitment related factors were major themes of female students' poor academic performance and Competency.

Table 2 Summary of Literature review of Experience of women engineers participation in Employment

Authors	Their finding
Singh. S (2014)	Concludes that women in growing numbers are joining engineering in India and making significant dent but even then, it is at the lower side when compared with other disciplines of education as science, medical and arts. Even after joining in to the labour market, their number decreases.
Clem Herman (2015)	The researcher argued that employment in science, engineering and technology are male-dominated sectors. This is not limited to young first-time graduates but continues and evolves throughout the life course. Mature women students, who are returning after career breaks, face a number of barriers in re-entering such employment sectors
Ghiasi. G et al. (2015	The findings reveal that men dominate 80% of all the scientific production in engineering. Women engineers publish their papers in journals with higher Impact Factors than their male peers, but their work receives lower recognition (fewer citations) from the scientific community. Engineers regardless of their gender contribute to the reproduction of the male-dominated scientific structures through forming and repeating their collaborations predominantly with men. This create discernment.
Pradeep Kumar	The finding shows that there is smaller percentage of women engineering

Choudhury (2015)	graduates than men have got job and offered earnings of women are about 54% less than that of men.
E. Schlenker (2015)	Finds that women, especially mothers, in STEM work more hours, but have a higher probability of being out of the labour force. The estimation results show that women in STEM work less hours in countries with higher levels of family allowances. However, this effect is small in size compared to the overall effects of larger levels of expenditures on family allowance and child benefits.
J. Gill et al. (2008)	Found that investigations of the attitudes and experiences of working engineers at three large firms suggest that engineering workplaces continue to be uneasy environments for professional women.
Samira I. Islam (2017)	Shows graduate women attempt to pursue career or postgraduate degrees are often excluded on bases of their gender and marginalized therefore much less to enter and remain in the job. In principle, there are equal opportunities for both genders in many Arab States, but social perception and prejudice determine which types of employment are particularly suitable for women or men.
Y. Tao et al. (2017)	Findings from negative binomial regressions show that women publish less than their male counterparts in science but not in engineering in the U.S. In China, women do not differ from men in publication productivity in science but publish more than their male counterparts in engineering. In addition, some background variables affect men's and women's publication productivity differently. That show women is better in China than US.
Tamiru Jote (2017)	Founds Substantial variations are observed among graduates of the various engineering disciplines and between men and women: civil engineers have better employment prospects, and the employment status of women is consistently lower because of education– job mismatch.

Conclusion

This review concludes that as it is appointed by various researchers, there are many factors that affecting academic performance of women in engineering education which contributes low performance than their counterpart. This low and insufficient academic performance intern leads to low participation in engineering employment or engineering labor market. In general leads to women being underrepresented in engineering education and employment. This shows there should be given emphasis to solve this problem of gender disparity in engineering life.

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