

Chapter # 24

CHALLENGES FACED BY FEMALE LEARNERS FOLLOWING AN ENGINEERING CAREER IN SOUTH AFRICA

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ABSTRACT

The objective of this study is to examine the specific problems that arise in a society with patriarchal attitude toward women and their choice of a future career. Within the University of South Africa (UNISA) College of Science, Engineering and Technology (CSET) started a community engagement programme called GirlPower in 2009. To understand better the hurdles faced by the female learners while choosing an engineering career, the authors carried out a survey among a sample of 74 future female engineering students, currently part of the “GirlPower” group. It emerged that although 99% of the female learners enrolled for mathematics and physical science only 32 % intend to continue with engineering studies at tertiary level. The big problem is parental and society attitude toward a female child being “able” to study engineering. Looks like our female engineers just “disappear”. The current survey shows a relatively bleak picture of the future of female engineers even if the schools in Johannesburg area are among the best in the country. Based on the present survey the authors will attempt to suggest some solutions to the problems faced by female learners.

Keywords: female learners, engineering career.

1. INTRODUCTION

The challenges to ensure fair access across the whole spectrum of the society to engineering education are multi-faced, and not unique to South Africa. The student’s rate of success in tertiary education is directly linked to the quality of high school education and the parental / community attitude toward tertiary education. Through a study (Ionescu, 2011) done by the author in 2013 over a large sample of engineering students, it was found that in South Africa the parental attitude toward tertiary education is very positive but the ability of a child to enrol for tertiary education is restricted by poverty and sometime lack of career guidance at high school level. The study carried out by the authors, reflects some of the daunting realities that young women are facing if they want to pursue an engineering career. The South African society although still very divided along economical and racial lines, agrees over the fact that engineering is not exactly a “right” career path for a woman.

Today all career opportunities in engineering are opened to women, which make sense as 51% of South African population is female (Mid-year population estimates, 2017). For the industry to ignore over 50% of the available human resources would be suicidal in the global competitive environment. To the credit of most companies, the bursaries for engineering education are deliberately targeting women belonging to the previously disadvantaged communities. Women protection and promotion policies are fundamental toward attaining real freedom and empowerment. Despite the Constitutional protection that the women enjoy,

our extremely patriarchal society has a problem tolerating women in the engineering field. To date the average proportion of female students in the engineering field are only about 20 – 25 % (Ionescu, 2010).

2. HIGH SCHOOL CHALLENGES

2.1. What to study

In the present survey several questions were asked relating to career choice as shown in table 1.

*Table 1.
Reasons to follow an engineering/ science career.*

What is your reason to follow an engineering / science career											
Roll model in the family (a family member is an engineer / scientist and you would like to follow in his/her steps)			From your childhood you dreamed to become an engineer/scientist			Did you ever receive any advice regarding your career choice while in the high school?			You were offered a bursary with the condition to study engineering/science		
yes	no	N.A	yes	no	N.A	yes	no	N.A	yes	no	N.A
12%	83%	5%	7%	56%	37%	65%	26%	9%	8%	90%	2%

Considering the data in table 1 there is no really clear reason emerging for choosing the engineer career. Looks like the career choice advice received in high school by 65 % of the students may have played a role but then 90 % of the students were not offered any incentives by means of a bursary to follow the engineering path. The present survey had only female students, members of the “GirlPower” group, and relates to a survey conducted among male students at the University of Johannesburg shown in tables 2 and 3

*Table 2.
Discrimination and gender relation, male students only.*

Discrimination and gender relation, male students only (128)								
Is the engineering profession not suitable for women because:			See female engineers as a treat to male job security			The women should stay at home and perform traditional family care duties		
Is dangerous	Too physically demanding	na (no answer)	yes	no	na	yes	no	na
14	16	98	18	107	3	12	112	4
11%	12,5%	76,5%	14%	84%	2%	9%	88%	3%
Government women promotion policies discriminate against male engineers			Objection against engineering career for a close family member					
yes	no	na	yes		no		na	
51	71	6	23		100		5	
40%	55%	5%	18%		78%		4%	

Table 3.
Who will you choose to educate?

As the head of household with scarce resources, who will you choose to educate				
	A male child	A female child	both	No answer
Female students (32 students)	2 6%	26 81%	0 0%	4 13%
Male students (128 students)	108 84%	2 1,5%	2 1,5%	16 13%

The potential female engineering student is handicapped from start due to the patriarchal society in which they live. A male household head will send to study engineering 84 % of male children and only 1.5 % of female children. Although the answers listed in tables 2 and 3 tend to be “politically correct”, the underlying trend is that the male engineers are weary to say at least, by female competition for engineering jobs. In a survey carried out by the authors among industry people in senior management position, remarkably the middle-aged males were 100 % against the engineering profession for a female close relative. The reason for this opinion was mainly that the working environment is not suitable for women, too ruff, dangerous, too physically demanding etc. The real reason is that in a patriarchal society like ours, a wife or daughter “belongs” to the family head who decides what is best for her.

2.2. What the school can offer

Table 4.
What the school can offer.

At your high school did you study:											
Mathematics and Physical Science?			Mathematics literacy?			Were there offered in your school any engineering subjects such as technical drawing, mechanics, etc.			Did you have access to a computer and learned computer skills during high school?		
yes	no	N.A	yes	no	N.A	yes	no	N.A	yes	no	N.A
82%	8%	10%	14%	54%	32%	29%	19%	52%	52%	46%	2%
How do you feel about the teaching at your high school											
Do you have the feeling that you are unable to keep up the pace and you feel left behind			Do you study every day?			Do you study only before tests and exams?			Do you have subjects that you just do not understand?		
yes	no	N.A	yes	no	N.A	yes	no	N.A	yes	no	N.A
82%	8%	10%	14%	54%	32%	29%	19%	52%	47%	51%	2%
Do you have a library at your high school?											
Do you know how to use the library facilities (to look for a book using the computer in the library)?			How many times per week you go to study in the library?			Is the library staff helpful and polite toward you?			Are you also using the community library?		
yes	no	N.A	2-3	1	0	yes	no	N.A	yes	no	N.A
12%	78%	10%	1%	50%	49%	44%	7%	49%	7%	71%	22%

Challenges Faced by Female Learners Following an Engineering Career in South Africa

In the modern age that we are living in, the most worrying problem is the lack of electronic equipment and internet access in the high schools. Considering that the Girl Power students are from schools in Johannesburg in the rural area the problem is amplified many folds. Also, the self-study skills that a learner should acquire in high school is not happening with only 12 % of students using the library facilities and 49 % never going to the library. Unfortunately, the situation did not improve at all over the years. Table 5 (Ionescu, 2014) shows the results of a survey done in 2014 and the computer literacy improved by only 11 % over the last 3 years.

*Table 5.
Subjects offered by schools.*

HG mathematics HG physical science (offered at school)			SG mathematics SG physical science (student choice)			High grade mathematics and physical science teachers employed at the school		
yes	no	na	yes	no	na	yes	no	na
92	20	2	28	76	10	70	21	23
81%	17%	2%	25%	67%	8%	62%	18%	20%
Engineering subjects offered at school			Aces to computer literacy at school			Some of the students are from technical colleges, which explains the “na” (no answer) regarding high school subjects		
yes	no	na	yes	no	na			
30	80	4	47	64	3			
26%	70%	4%	41%	56%	3%			

2.3. The integration of practical engineering / science experiments in the high school curriculum

Proving theoretical concepts through laboratory experiments is extremely important for the future engineer. The science notions become less abstract and helps understand them better. Unfortunately, the “Virtual laboratory experiments” are not an option as only 52 % of the students have access to a computer. Table 6 shows the results of the current survey.

*Table 6.
Who is performing the laboratory experiments?*

Do you have a science laboratory at your high school?											
Do you know how to use the laboratory equipment?			Is only the teacher demonstrating the laboratory experiments?			Are the learners allowed to perform the laboratory experiments?			Were you provided with a science kit at the beginning of the term?		
yes	no	N.A	yes	no	N.A	yes	no	N.A	yes	no	N.A
65%	30%	5%	64%	32%	4%	32%	64%	4%	40%	58%	2%

Because in 64 % of the cases only the teacher can perform the science experiments, the laboratory role is diluted. Becomes something unattainable with students losing interest and not paying attention. The Engineering Council of South Africa (ECSA) as a regulatory body of engineering teaching, requires as compulsory a minimum of three relevant laboratory experiments to be performed by each student. The results in table 7 shows just how important the laboratory experiments are (Ionescu, 2014).

Table 7.
The relevance of laboratory experiments in engineering modules.

The relevance of laboratory experiments in engineering modules								
The students struggle to handle the laboratory equipment			The laboratory experiment is relevant for all mechanics of machines modules			The laboratory experiment is relevant for all strength of materials modules		
yes	no	na (no answer)	yes	no	na	yes	no	na
6	94	14	92	8	14	98	2	14
5%	83%	12%	81%	7%	12%	86%	2%	12%
The laboratory experiment is relevant for all fluid mechanics modules			The laboratory experiment is relevant for all thermodynamic modules			The laboratory experiment is relevant for all mechanical engineering manufacturing modules		
Yes	no	na	yes	no	na	yes	no	na
98	2	14	99	1	14	90	10	14
86%	2%	12%	87%	1%	12%	79%	9%	12%
The integration of the laboratory experiments into module enhanced the students understanding of the module and their academic performance								
Yes	No	Na						
90	10	14						
79%	9%	12%						

In South Africa, the Engineering National Diploma programs have the work integrated learning (WIL) module as part of the qualification, whereby a whole year is spent in industry. Due to a total lack of basic engineering skills of the majority of our future engineering students, the industry placement is very difficult as the industry tend to see them as a liability. However, all efforts must be done in this regard as the WIL in tertiary education and laboratory experiments in high schools helps with understanding of difficult modules as per below table (Ionescu, 2014).

Table 8.
Work integrated learning experience.

After work integrated learning the general understanding of engineering profession was enhanced			After work integrated learning the students' academic performance was enhanced		
yes	no	na	yes	no	16%
16	3	5	13	5	6
67%	12%	21%	54%	21%	25%

3. SENIOR CERTIFICATE GRADUATES IN SOUTH AFRICA

The high school graduates are facing many challenges and unfortunately political interference. According to South Africa's matric pass rate: 2007 – 2017 the pass rate fluctuated around 70 %. The matric pass rate has shown major improvement sanctioned by the ruling party – hitting an all-time high of 78.2 % in 2013 – which sent alarm bells ringing among academics, who claim to have not seen any real improvement in the quality of South African education over time (South Africa's matric pass rate: 2007 – 2017, 2017). Table 9 shows the matric pass rates statistics over 10 years as compiled by the Department of Education of South Africa.

Table 9.
Matric pass rate.

Year	Pass rate	Change	Year	Pass rate	Change
2007	65.2%	-1.3	2013	78.2%	+4.3
2008	62.5%	-2.7	2014	75.8%	-2.4
2009	60.6%	-1.9	2015	70.7%	-5.1
2010	67.8%	+7.2	2016	72.5%	+1.8
2011	70.2%	+2.4	2017	75.1%	+2.6
2012	73.9%	+3.7			

This official statistic is refuted by the opposition party because the official pass rate does not tell the full story – ignoring the large percentage of students who drop out before they write the matric exams. Equal Education (a non-profit organization) has described the matric pass percentage as a superficial and misleading indicator of public education quality.

“The pass rate reflects only the performance of those learners who managed to stay in school for 12 years and obscures how many dropped out along the way,” (South Africa's matric pass rate: 2007 – 2017, 2017) while the Basic Education Department has systematically failed to address learner retention. For a broader perspective, a cohort matric pass rate should be used. Equal Education defines the cohort matric pass rate as the percentage of learners in grade 2 who pass matric 11 years later.

Of the 1,022,853 grade 2 cohort enrolment, only 629,155 students registered for the matric final exams. This is a dropout rate of 38.49 %. When one considers only the 534,484 grade 12 students who wrote matric, this dropout rate increases to 47.75 %. The 2017 cohort matric pass rate, which Equal Education has referred to as the true pass rate, is therefore 39.25 % and this is cause for serious concern (South Africa's real 2017 Matric pass rate 39.25%, 2017).

Table 10.
Cohort pass rate.

Year	Registered for matric exams	Pass rate	Cohort enrolment in gr. 2	Cohort pass rate
2017	629,155	75.1%	1,022,853	39.25%
2016	674,652	72.5%	1,081,652	41.98%
2015	667,925	70.7%	1,118,690	41.65%
2014	532,860	75.8%	1,109,201	37.2%
2013	562,112	78.2%	1,111,858	40.42%
2012	511,152	73.9%	1,012,892	38.07%

3.1. Female matric / engineering graduates in South Africa

Among all this political turmoil interfering with basic education the most vulnerable are the female students. If a female student is failing high school the family most likely will stop sending the female child to school. Fortunately based on different statistics the female learners are performing better than the male learners although they have less support from family and society. Once the female child graduate from high school, enter a tertiary engineering and graduate, her problems do not stop. After graduation the young engineers do not struggle to find employment as there is a shortage of engineers worldwide and especially in South Africa. However, based on a survey conducted among engineering companies (Ionescu, 2013) an inexplicable picture emerges. Looks like our female engineers just “disappear”. Judging by the engineering graduates’ numbers, the female engineers represent about 21,5 % of the total number of graduates. However, in the working place, an engineering company with 420 employees and not one female engineer employed, is common occurrence. One of the major engineering businesses surveyed, employs 46 women, amounting to about 30 % of the total staff complement. This percentage promotes a skewed view of female employment rates, as in reality there are no female engineers and only 5 female machine operators. The other 41 female staff members are cleaners, kitchen helpers, etc. The reality confirms that implementing women friendly legislation is not enough and more radical measures are called for. The current legislation requires businesses to report on the number of women employed but does not require them to specify the job descriptions of these women. As a result, the businesses meet some government targets without contributing toward women empowerment. Most small and medium sized companies do not have any female engineers in their staff complement.

One of the very large international company just started a tertiary education bursary scheme, a graduate development program and a campus engagement initiative. However, the company recruited 34 engineering bursars out of which only 9 were female (26, 5 %). A company whose main business is civil engineering and plant commissioning agrees that the industry is tough. The company’s work is contractor work therefore the engineers must go where the work is. This is difficult for working mums as they need to move and travel. Many of the male engineers do not move their families but go home in weekends. As the women engineers do not want to be treated differently from their male colleagues, the company encourage this trend which conflicts with the women role as home maker, wife and mother.

4. MEASURES TO BE TAKEN TO CORRECT THE PROBLEM

- Increase in number of bursaries offered to female students.
- Introduction of engineering subjects such as technical drawing, mechanics, etc. in high school curriculum
- Computer literacy must be a compulsory subject in high school, obviously backed by computer hardware availability in all schools. The urban schools generally are well equipped while most rural schools are totally deprived. A staggering 46 % of students (table 4) enrol for engineering studies without ever touching a computer before.
- An urgent need to address the shortage of well qualified teachers able to teach mathematics and physical science.
- Educate the high school learners about the importance of choosing mathematics and science courses if their career choice will be engineering.
- The number of women employed should be reported together with their qualification and the job they perform to avoid skewed statistics,
- In-house training for new employees should be prioritized to groom them for management positions,
- The balance between work and family life should be promoted.

5. CONCLUSION/DISCUSSION

Generally, the schooling of female children in South Africa is difficult. The main problem is the patriarchal society in which the female children exist. It is current occurrence to send a female child to study professions perceived as suitable for women such as nursing, social work and school teaching. There is a need for a radical change in attitude toward the professional freedom of the female students in family and society. The mining industry is a major employer in South Africa but before the Mines Health and Safety act of 1996 women were allowed underground only as members of service delivery teams (Ionescu & Buisson-Street, 2008). The harsh physical work environment (+ 3km underground) was considered unsuitable for women and throughout Africa there is a belief that if a female goes underground, the stones (minerals) will disappear. However in spite of everything the first woman was awarded a Blasting certificate in 1999. Currently there are many female miners and mining engineers. On a lighter note in our survey the Girl Power students were asked if they consider South Africa as a first world country when it comes to shopping and the overwhelming answer was yes (92 %).

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