

## Factors influencing female Emirati students' decision to study engineering

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**ABSTRACT:** Despite the intensive focus and resources devoted to recruitment and retention of female engineering students over the past several decades, women remain underrepresented in the field of engineering. Although recent global trends reveal an increase in women enrolling in engineering, in the United Arab Emirates (UAE) women are still a minority amongst engineering students, mainly because until recently engineering programmes were not accessible to female Emirati students. However, with the establishment of several engineering-only institutions and the launch of single-gender engineering programmes, female Emirati students are gradually entering this non-traditional academic and career path. This article is based on a study conducted at the Petroleum Institute, where seventy-five undergraduate female engineering students participated in the study. The aim of this research study was to identify factors that influence Emirati female students' decision to study engineering.

**Keywords:** Female engineers; engineering education in United Arab Emirates; Emirati engineers

### INTRODUCTION

The higher education sector in the United Arab Emirates (UAE) has witnessed a rapid growth since the establishment of this country 39 years ago, with 70 institutions of higher education presently licensed by the UAE Ministry of Higher Education and Research [1]. At the present time, women make up 65% of university graduates in the UAE [2].

However, despite the efforts of the UAE government in providing employment incentives for women, the overall number of female graduates in engineering fields remains low compared to the non-engineering fields. For example, at the country's largest public university, the United Arab Emirates University (UAEU), during the period 1980 to 2009, female engineering students made up only 3% of the total number of university graduates [3].

While the overall rate of female enrolment in engineering studies in the UAE remains low, its growth rate has exhibited a positive trend [3]. The recent establishment of engineering-only institutions, such as the Petroleum Institute and the Khalifa University of Science, Technology and Research, provide further opportunities for women to pursue engineering education in the UAE.

For example, at the Petroleum Institute, 35% of the total undergraduate population consists of female students. Following its first cohort of female engineering students in the fall of 2006, female engineering students educated at the Petroleum Institute are amongst the first female engineers in the UAE. They will play an integral role in shaping the path that future generations will follow. Amongst the participants of this study, nearly 70% were the first women in their family to study engineering. Hence, these statistics give importance to the contemporariness of the field of engineering amongst women in the UAE.

The purpose of this study is to examine the factors that influence the decision of female Emirati students to study engineering. Given the lack of research on the subject matter amongst Middle Eastern students, it is believed that this study will add to the existing body of knowledge on female students' decision to enter the field of engineering, particularly in a fast growing economy such as the United Arab Emirates. Specifically, the study examines the role and influence of social background, role models, perceived strength in mathematics, recruitment measures, and employment opportunities, on Emirati female students' decision to enter the field of engineering.

## LITERATURE REVIEW

Historically, the engineering profession reveals male dominance and a systematic marginalisation of women. According to Canel and Zachmann:

*...only when women's historians began to ask about women engineers did historians of technology acknowledge that the engineering profession is one of the most male dominated professions [4].*

While the engineering profession and education date back to the pre-industrial era, it was not until the early 20<sup>th</sup> century that women in the United States and Europe began to gain better access to engineering education [4][5]. Even though female students exhibit high academic performance in mathematics and sciences, the number of women studying in engineering fields remains significantly low [6]. According to recent statistics from the United States, only 17% of students graduating with a Bachelor degree in engineering are women. In comparison, women make up almost 50% of students graduating with a Bachelor degree in social sciences and history [7].

Higher education is often seen as a way to achieve a higher social status and is an effective recruitment strategy for female students. Many studies have found a direct correlation between the level of representation of university students and their parents' education and income levels [8-11]. Furthermore, survey results indicate that female academics, in comparison to their male counterparts, come from a distinctly narrower social background [8].

Studies show that interest in mathematics is a strong factor linking female students to their decision to study engineering [8][12][13]. Women who believe they are good in mathematics are more likely to study engineering with results being more pronounced for those who attended single-gender schools [13]. Furthermore, research indicates that parental support is critical for female engineering students as it correlates with higher scores in mathematics [14][15].

Women appear to be more successful in single-gender as opposed to mixed-gender educational environments [6]. Single-gender education appears to provide female students with a unique social environment in which they can reach beyond the stereotypical career expectations. The competitiveness and lack of male intimidation in single-gender education provides women with the confidence and empowerment required to choose non-traditional post secondary educational paths, such as engineering [16]. Additionally, women studying at single-gender schools have higher career aspirations than those studying at co-educational schools [17].

Gender roles often limit female students in achieving higher educational goals and choosing non-traditional career paths; hence, the existence of strong support and role models facilitates female students to achieve higher academic and career goals [8]. In one particular study, female students complained of the lack of role models, and instead approached career advisors, teachers and parents for educational advice [13]. Another study indicates that while female engineering students felt encouraged by both parents, they felt more influenced by their fathers [8].

Studies have revealed that when female students are not exposed to female role models in engineering, most assume that these opportunities are not open to them; hence, they never consider giving engineering careers a try. A Canadian university started a campaign to motivate female students to choose engineering. To show that engineering was a possible profession to consider, the university sent programme posters and brochures to heads of science departments, guidance-counsellor and science teachers at 500 high schools. The posters and brochures showed pictures of female engineers on field and provided students with information on engineering careers.

As part of this campaign, the university also started a Discover Engineering Summer Camp to educate female students about the challenges and rewards of engineering; eventually, 60% of the camp participants went on to pursue engineering and cited the camp was a key factor in their decision [18]. Other studies reveal that advertising measures such as posters showing female students using machinery and advertisements specifically stating that academic programmes accept female students, have a positive influence on the recruitment of female students [8].

The labour law of the United Arab Emirates supports employment and equal pay for all women [19]. The founding President of the UAE, the late Sheikh Zayed bin Sultan Al Nahyan, stressed that all Emirati women should be given the chance to travel abroad in order to pursue higher education and later assume managerial roles in the work place [19].

While the number of Emirati women in the labour force has tripled during the ten-year period between 1995 and 2004, women still form a small percentage of the overall labour force [20]. Furthermore, statistics indicate that 32% of Emirati females believe they are unfairly treated in the workplace due to their gender [2].

## RESEARCH QUESTIONS

The aim of this study was to identify factors that influence Emirati female students' decision to study engineering. The research questions of this study were:

- What is the relationship between Emirati female students' social background and their decision to study engineering?

- What is the relationship between students' self-perception of mathematical ability in secondary school and their decision to study engineering?
- What is the relationship between female students' role models and their decision to study engineering?
- What is the role of recruitment measures in influencing Emirati female students' decision to study engineering?
- What is the relationship between career opportunities and Emirati female students' decision to study engineering?

## METHOD

### Participants

The present research was carried out at the Petroleum Institute located in Abu Dhabi, the capital city of the UAE. The institute opened its doors in 2001 to male-only students. In 2006, the Institute accepted its first cohort of female students. Both Bachelor and Master degrees are offered in four engineering programmes: mechanical engineering, electrical engineering, chemical engineering and petroleum engineering. Further engineering degrees, such as materials engineering and health, safety and environment engineering, are planned for the future.

Female and male students study in two separate, but adjacent campuses. At the time of writing this article, a total 1,050 students were enrolled in the institute's undergraduate programme of which 35.1% were female students and 64.9% were male students. The experimental group ( $N = 75$ ) consisted of female engineering students enrolled at the Petroleum Institute. The experimental group was selected randomly from students enrolled in each of the four engineering programmes. The degree programme representation in the surveyed sample was 10.9% for chemical engineering, 36.4% for electrical engineering, 36.4% for mechanical engineering and 16.4% for petroleum engineering. Class representation in the surveyed sample was 3.6% freshmen, 40% sophomores, 21.8% junior and 34.5% seniors.

### Data Collection Instrument

A questionnaire was used as the instrument for data collection. The questionnaire had five distinct components: a) questions related to social background; b) questions related to academic background; c) questions related to recruitment measures; d) questions related to perceived employment opportunities in the UAE; and e) questions related to student role models. To ensure a large number of responses, the questionnaire was given to students in the classroom by one of the researchers and administered over a 15 minute period. To ensure that answers were spontaneous, the survey was administered without prior notification. The questionnaire consisted of 20 closed-ended multiple choice questions, following a combination of dichotomous, polytomous and 5-point Likert scales.

## RESULTS AND ANALYSIS

### Social Background

A paired t-test was used to determine whether the average education of the students' parents in the sample was statistically different. A paired sample t-test indicated that, on average, the students' fathers had a higher education level than their mothers ( $t(75) = 2.315$ ,  $p = 0.024$ ,  $d = 0.31$ ). In the sample, 63.6% of the fathers had post secondary education (associate, Bachelor, Master or doctorate degrees), compared to 52.6% of mothers. The results also indicated a high employment rate among the parents of the students in this study. The results confirm similar research findings that parents of female engineering students have high education levels [9-11]. However, 65.5% of the students responded that neither of their parents had studied engineering. The results contrast with those of Kvande, who found that majority of the parents of female engineering students came from a technical background [8].

Students were asked if both of their parents were supportive of their decision to study engineering. Out of the 75 students, 96.3% claimed that both of their parents were supportive of their decision. A binomial test revealed that there is statistically significant parental support for female students studying engineering ( $p = 0.000$ ,  $p < 0.05$ ). The findings are consistent with those in the literature, which indicate that female engineering students receive high levels of parental support when deciding to study engineering [21][22]. When asked to identify the one individual that encouraged them the most to study engineering, 50% of our sample responded that they were encouraged by their father, followed by 18.2% by their mother, 18.2% by a friend, 6.8% by a teacher and 6.8% by a sibling. The results are consistent with other research findings in that female engineering student are encouraged the most by their fathers to study engineering [8][23][24].

### Role Models

Given the under-representation of women in the various fields of engineering, one can suggest that having female engineers as role models is important for encouraging female students to study engineering, as well as overall confidence-building throughout their course of study. It has been suggested that hiring more women faculty members could help increase the representation and success of women in traditionally male-dominated fields [25][26]. While the number of female engineering professors has increased since the establishment of the Institute, it still remains significantly low in comparison with the number of male engineering professors. Of the 75 students in this sample, 20%

stated that over the past year they had no female engineering professors, while 65.5% stated that they had 1-3 professors and 14.5% of the students stated they had 3-5 engineering professors.

In this study, students were asked to indicate the degree of importance of having female engineering professors using a five-point Likert scale. The results ( $N = 75$ ,  $M = 2.89$ ,  $SD = 1.149$ ) indicated that 12.7% strongly agreed, 10.9% agreed, 40.0% neither agreed nor disagreed, 25.5% disagreed and 10.9% strongly disagreed. A chi-square goodness of fit test revealed a significant difference among the student's perceptions about the importance to having female engineering professors  $\chi^2 = 17.818$ ,  $df = 4$ ,  $N = 75$ ,  $p = 0.001$  ( $p < 0.05$ ). Given that the majority of the respondents in this sample, were either impartial to, or disagreed with, the idea that having female engineering professors is important, the results support the findings of Bettinger and Long [26], who found that female engineering professors are not seen to have a statistically significant effect as role models on female engineering students.

#### Self-perception of Mathematical Ability in Secondary School

Studies have indicated that students who perform better in mathematics in high school are more likely to study engineering at university [8][12][13]. In this study, the aim was to find the relationship between students' self-perception of mathematical ability in secondary school and their decision to study engineering. Students were asked to indicate the degree to which they thought mathematics was one of their strongest subjects during high school using a five-point Likert scale. The results ( $N = 75$ ,  $M = 4.05$ ,  $SD = 1.113$ ) indicated that 43.6% strongly agreed, 32.7% agreed, 14.5% neither agreed nor disagreed, 3.6% disagreed and 5.5% strongly disagreed. With 76.3% of the respondents professing their confidence (either strongly agreeing or agreeing) in their mathematical ability at high school, the findings agree with the existing studies that students, who have high mathematical abilities are more likely to pursue engineering [8][12][13].

#### Recruitment Measures

In order to identify the most effective recruitment measure, students were asked how they came to know about the engineering programmes at the Petroleum Institute. In particular, students were asked: a) if officials from the Institute visited their high school; b) they attended one of the Institute's open days; or c) they came across advertisements about the engineering programmes at the Institute. The results indicated that 46.2% had seen an advertisement about the Institute's engineering programmes, 44.2% of the students were visited at their high school by a representative from the Institute, and 9.6% visited the Institute's open day. A chi-square goodness of fit test revealed a significant difference among students as to how they came to learn about the Institute  $\chi^2 = 13.192$ ,  $df = 2$ ,  $N = 75$ ,  $p = 0.001$  ( $p < 0.05$ ). While the authors cannot identify the reason for the low number of female participants during the open days, the results are in agreement with the authors' personal observation that the number of male student visitors largely outnumbers those of female students during the Institute's annual open days.

Presently, male and female engineering students at the Petroleum Institute study on segregated campuses. This arrangement was created to adhere to the local Emirati culture and to offer female students the opportunity to study engineering in an all-female educational setting. The popular belief is that most families and students prefer a single-gender educational environment, hence making the segregated educational arrangement of the Petroleum Institute an important recruitment measure. On this subject, students were asked to indicate the degree of which they thought it was important for male and female students to study in segregated campuses using a five-point Likert scale. The results ( $N = 75$ ,  $M = 3.02$ ,  $SD = 1.269$ ) indicated that 16.4% strongly agreed, 16.4% agreed, 34.5% neither agreed nor disagreed, 18.2% disagreed and 14.5% strongly disagreed.

A chi-square goodness of fit test did not reveal any statistically significant difference among the student's perceptions that it was important for male and female students to study in segregated campuses  $\chi^2 = 7.455$ ,  $df = 4$ ,  $N = 75$ ,  $p = 0.114$  ( $p < 0.05$ ). The results indicated a varied preference among female students towards studying in a segregated educational setting. This could indicate either a discord between the preference of the students and their parents, or an indication that studying at a single-gender campus is not a determining factor for the students to attend the Institute's engineering programmes.

#### Employment Opportunities

Students were asked to indicate the degree to which they felt confident of finding a job in engineering upon graduation, using a five-point Likert scale. The results ( $N = 75$ ,  $M = 4.44$ ,  $SD = 0.660$ ) indicated that 50.9% strongly agreed, 43.6% agreed, 3.6% neither agreed nor disagreed and 1.8% disagreed that they were confident to find a job in engineering upon graduation. All male and female students studying at the Petroleum Institute are sponsored by the Abu Dhabi National Oil Company (ADNOC); hence, prior to joining the Institute they are required to sign a multi-year contract to work for ADNOC or one of its operating companies upon graduation. This guarantees a job upon graduation for all graduating female students. Therefore, it was not surprising that nearly 95% of the female students in this sample indicated that they were confident that they would find a job after graduation. However, the results should not be indicative of the overall employment situation in the UAE. While the UAE government has launched several

Emiratization programmes that require government and private entities to hire and train Emirati citizens and reduce their dependence on expatriates, the unemployment rate among Emiratis remain high at 14.4% [27].

Students were also asked to indicate the degree to which they perceived that male and female engineers had equal job opportunities in the UAE, using a five-point Likert scale. The results ( $N = 75$ ,  $M = 3.38$ ,  $SD = 1.045$ ) indicated that 14.5% strongly agreed, 32.7% agreed, 32.7% neither agreed nor disagreed, 16.4% disagreed and 3.6% strongly disagreed that men and women possessed equal job opportunities in the UAE. A chi-square goodness of fit test revealed a significant difference among the student's perceptions about the equality of job opportunities among male and female engineers  $\chi^2 = 17.455$ ,  $df = 4$ ,  $N = 75$ ,  $p = 0.002$  ( $p < 0.05$ ). Even though 94.5% of the females in this sample were confident (strongly agreed or agreed) of finding a job upon graduation, 20% believed that men and women in the UAE do not possess equal job opportunities. This perception may be associated with social pressures, cultural traditions, or the general stereo-typing of the role of women in Middle Eastern societies [19][28-30].

## CONCLUDING REMARKS

In some respects, this study is a factual portrayal of women in engineering. The findings from this research indicated that a student's parents' field of education was not an influential factor in their decision to study engineering; however, similar to other research studies, these results showed that parental support and strong mathematical abilities were noticeable factors in their decision. While many studies have stated the importance of having female professors as role-models, findings from this study indicated that students did not perceive having female engineering professors as a significant factor.

Additionally, the results indicated that a majority of the students did not perceive a segregated campus to be an essential factor for choosing the institution. Moreover, the study confirmed that the recruitment measures are important in attracting female engineering students. A majority of the participants indicated that they either came across a recruitment advertisement for the Institute or were visited at their high school by a representative from the Institute, while only a small number of students indicated that they attended an open day.

The United Arab Emirates is a fast growing economy and a competitive participant in the world market. In order for the UAE to sustain its rapid growth, it requires a skilled local workforce educated in various areas of engineering and science. In view of the fact that Emirati women still remain an untapped potential in the field of engineering, the higher education institutions in the UAE offering engineering programmes must acknowledge the need to inform and inspire female high school students to consider the non-traditional career path to engineering.

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## BIOGRAPHIES



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