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Creating a knowledge-based economy in the United Arab Emirates: realising the unfulfilled potential of women in the science, technology and engineering fields

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As the United Arab Emirates (UAE) moves towards a knowledge-based economy, maximising the participation of the national workforce, especially women, in the transformation process is crucial. Using survey methods and semi-structured interviews, this paper examines the factors that influence women's decisions regarding their degree programme and their attitudes towards science, technology and engineering (STE). The findings point to the importance of adapting mainstream policies to the local context and the need to better understand the effect of culture and society on the individual and the economy. There is a need to increase interest in STE by raising awareness of what the fields entail, potential careers and their suitability with existing cultural beliefs. Also suggested is the need to overcome negative stereotypes of engineering, implement initiatives for further family involvement at the higher education level, as well as the need to ensure a greater availability of STE university programmes across the UAE.

Keywords: knowledge-based economy; innovation; STE; UAE

1. Introduction

Since the discovery of oil in 1982, the United Arab Emirates (UAE) has developed at breakneck speed, from one of the least developed nations in the world to a major international business and tourism hub, with an income per capita comparable with that of most industrialised nations. However, while the economy remains markedly dependent on oil and gas, significant efforts are currently being made to diversify the economy into knowledge-based industries (Abu Dhabi Council for Economic Development 2030). One of the prerequisites for creating such an environment that fosters innovation and knowledge production is to develop strong local capacity in the fields of science, technology and engineering (STE)[1].

Admittedly, the UAE has made significant progress with regard to education. The high literacy rate among both men and women (90%) is a major national achievement, especially given the high share of youth in the UAE population (Government of Abu Dhabi 2008).[2] Also, the share of

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women entering higher education and their further integration into the workforce has consistently increased over the past two decades and currently constitutes 65% of graduates in the UAE (UNESCO 2009). However, several challenges remain with regard to human capital. An important challenge is that nationals are a minority in their own country, only 20% of the population (UAE Ministry of Economy 2008). As a result, the fast growth has relied primarily on foreign knowledge workers (Al Rostamani 2004), who constitute the vast majority of the labour market in the UAE, 91% (Freek 2004, TANMIA 2006). Additionally, despite an increasing trend, female participation in the workforce remains low, around 28% (UAE Ministry of Economy 2008).

The under-representation of women in the workforce is especially surprising when one considers that they are the majority in tertiary education (UAE Ministry of Economy 2007, UNDP 2009). Moreover, girls perform better in school than boys (MHESR 2010). Reducing this gender gap is of concern, given that the integration of women in all fields is key to economic growth (Klasen 1999, Lagerlöf 1999, Schultz 2002) and to creating local capabilities for innovation (Eriksson *et al*. 2008, Vidican 2009).

The development of Emirati's intellectual capital in the STE fields is critical to further facilitate a successful and sustainable transformation process. As Al Khateeb *et al*. (2007) state: '…good education is a prerequisite before new technologies can produce economic benefits'. Otherwise, they will be unequipped to take ownership of innovative processes, adapt new technologies to suit their own environmental needs, adequately meet new challenges and expectations, as well as increase the country's internal knowledge (Hays and Farhar 2000). In an era where a country's competitive edge relies more than ever on technological innovation, a low supply of national high-calibre STE graduates is a barrier in the economic transition process and makes it more difficult for both the government and private firms to find and employ local talent.

As such, macro-level strategic discussions about the UAE's industrial diversification would be misguided without a deeper analysis of the underlying factors (institutional, cultural, social, economic, etc.), which influence the development of human capital in the country. Therefore, the purpose of this paper is to address the following research questions, with the primary unit of analysis being female students enrolled in universities across the UAE:

(1) What are the factors that influence women's decision to enrol in STE disciplines?
(2) What policy recommendations and actions can be developed to increase women's engagement in STE fields?

Understanding the local context shaping women's choices regarding education and career, and subsequently adapting mainstream policies to the specifics of the environment, is pivotal for successfully expanding the participation of women in society and the economy. The current findings point to a complex set of factors determining how female students in the UAE view STE fields. Although personal inclination and individualism are taking a larger role in the society, family remains one of the highest influences on women's decisions regarding education and careers. A palpable lack of perception of career opportunities in the STE field was found, as well as the existence of stereotypical views of the engineering field. Also, institutional barriers, such as the unavailability of university STE programmes in reasonable distance to students' residence, further deters students from entry into these fields.

2. Literature review

The under-representation of women in STE fields is not a new topic in science policy research. However, most studies have focused on Western countries (European Commission 2003, 2004), while research within the Middle East and North Africa (MENA) region has been limited. Existing

research relies mostly on secondary data conducted at the pan-Arab level and has not examined in greater detail women's participation in STE. Examples of such studies are the UNDP (2002, 2003, 2008) and UNESCO (2007, 2009) reports, which, although providing a thorough overview of these issues in the MENA region, do not perform in-depth country level analyses. This is important, as significant economic, social, political and cultural differences exist between countries in the MENA region (UN ESCWA, 2007), calling for policies and programmes that are tailored to the local context. In effect, little has been published at micro-level on the factors that affect Arab women's decisions regarding educational choices. Nevertheless, it must be mentioned that there have been recent efforts in this regard (Sulaiman and AlMuftah 2010), as well as others in the Islamic (non-Arab) world (Smith *et al*. 2007, Smith and Dengiz 2009).

One of the most commonly identified frameworks that influence decisions regarding STE relates to social-psychological perceptions (Acker and Oatley 1993). The underlying assumption is that the final decision lies with a person on whether or not to make a decision, for example, to enrol in STE. The Eccles' Model is an example of one of the tools to measure the factors that influence women's occupational choice (Eccles 1994), which states that any decision a woman makes relates 'to gender role beliefs, to self-perceptions and self-concept and to one's perceptions of the task itself' (p. 587). Interestingly, women have a preference towards non-maths-related careers, even when considering equally talented men and women (Lubinski and Benbow 1992), perhaps as a result of the negative stereotypes that permeate around these fields, traditionally viewed as male domains (Aronson *et al*. 1998).

The role of family members in women's educational choices is not to be overlooked. Family have long been identified as an important influence in women's educational choices, particularly as related to STE fields (Carter and Kirkup 1990, Phipps 2002, Lopez-Sáez *et al*. 2004, Takruri-Rizk *et al*. 2008). Byko (2005) states that parental support is the most significant factor identified by women working in STE fields to feel they 'could do anything' they wanted to do. Women are more likely than men to enter engineering based on encouragement from a family member than because of their own intrinsic interest (Ware and Lee 1988), as well as more likely to come from well-educated tight-knit families who value success (Sullivan 1993). In the Arab culture of the UAE, a family-based patriarchal society with clearly defined gender roles, the aspect of parental influence on educational choice is expected to be even more pronounced.

Without deeper evaluation, it would be difficult to effectively address the diverse reasons behind Emirati women's low STE enrolment and enable their greater participation in these fields. Based on the literature, a gap in the enrolment of female students in STE education has been identified. Although females are the majority of those educated at the tertiary level (UNESCO 2009), studies have shown a preference for entering into the social sciences, arts or business administration fields (UAE Census 2005); while, in contrast, in only two departments, Islamic Jurisprudence and Engineering, is male enrolment higher than females (Nelson 2004, Volk 2010). The present study is the first to systematically examine, at a national level, the unique reasons that affect women in the UAE in their degree programme selection and to explore the social, cultural and economic factors that affect their decision, while incorporating the STE perspective.

3. Research methods

Both qualitative and quantitative research methods were used to explore the reasons for the dearth of Emirati women in STE fields. The main instrument for data collection was through questionnaires distributed online to women students between the months of March and May 2010. The questionnaire was developed after conducting an extensive literature review to identify relevant issues concerning women in STE. Some questions were based on existing studies, such as

National Science Foundation (2005). But most questions were based on preliminary research on the local context of the UAE. Before distribution to the target population, a pilot test on a small convenience sample of 26 students was conducted and the results discussed with various stakeholders (educators and researchers) to help identify relevant topics and alterations needed. The final questionnaire was a 66-item set of multiple choice, Likert-scale and open-ended questions, with a dynamic skip-pattern approach incorporated based on students' responses.[3]

The questionnaire was circulated to 17 university campuses, which are the main federal and non-federal universities in each of the seven Emirates in the UAE. For comparative purposes, both Emirati and non-Emirati female students from STE and non-STE backgrounds were invited to respond. Around 2600 women students took part in the study, with 46% of them enrolled in STE fields. The majority of participants were Emirati, single, between the ages of 20–25 years, Muslim, studying their Bachelor's degree and from a middle class background.[4] The majority of parents were educated, with a higher diploma degree.

Given that, in the UAE, university student records are not shared with outside entities, it was not possible to draw a random sample for this study. Hence, any conclusion that is drawn is limited to the sample.[5] However, the diversity of the sample in terms of the geographic location of participants, type of disciplines and the mixture of both public and private universities adds significant value to understanding women's choices regarding educational options.

To obtain a more comprehensive understanding of the issues at stake, a total of 17 semi-structured interviews with an 'expert sample' were also conducted during the months of May and June of 2010. The interviewees were national female engineers working in industry, academics, university administrators, non-governmental organisation representatives, researchers and educational policy makers. The discussions were guided by an interview protocol, tailored to the experience and knowledge of the interviewee. The interviews were audio taped, transcribed, coded and analysed.[6]

4. Discussion of results

In analysing the data, and specifically in their approach to understand the instrumental elements determining a woman's educational choice, the researchers looked into the different factors shaping her decision, the role of family in affecting her choice, perceptions regarding the STE fields, as well as other barriers that determine her future.

4.1. *Main motivators in study selection*

It was intriguing to learn about the main drivers for students in selecting their field of study, and so students were asked to identify the main reason behind their choice. The majority of students stated that personal inclination defined their selection (50%), a finding that is not unique to the students in the UAE (Sjödin 2001, Ramberg 2006). This suggests, quite simply, that to increase women's participation in STE, one has to stimulate students' interest in these fields. However, it was found that individual choice and preferences are in a state of transition as they become more important in the context of decision making in the UAE, when, traditionally, family has taken precedence over the individual. A comment from one of the interviewees is revealing in this regard:

'It's not like it used to be. In the past…there were some set rules. I think these barriers are gone now. The society has changed… More and more it's student's choice. So now, you need to educate the students more about the choices they have …how to choose a career...You need to work on the students themselves …You need to direct them.'[7]
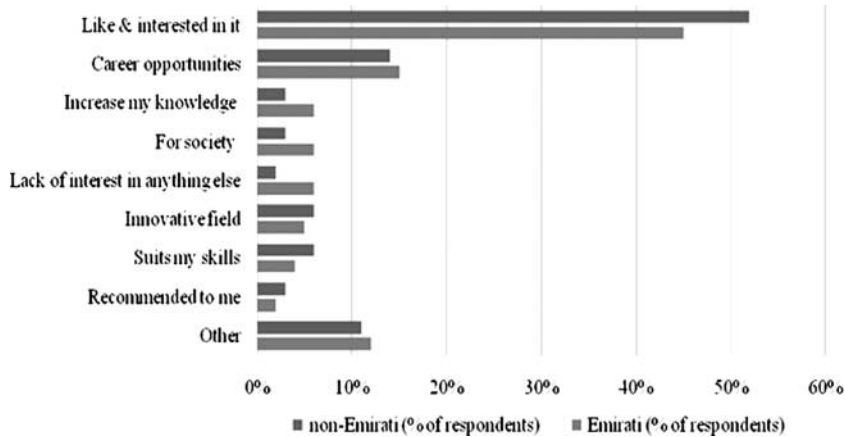
Figure 1. Reasons for choosing the field of study, by nationality (n = 1194). The category 'Other' includes a diverse range of motivators for study selection, such as the good quality of education in the field, the lack of interaction with men, suitability for women, the expected interaction with people and the 'easiness' of the job.

Although Simadi (2006) reports that religious values are the number one value structure for students in the UAE, the researchers found little reference to religion as a motivating factor for pursuing higher education. This said, references to culture and tradition were found. Additionally, it was found that students lack awareness of opportunities available to them, as well as of their own abilities. This became especially evident when comparing Emirati and non-Emirati students (see Figure 1), Emiratis being three times more likely to indicate a 'lack of interest in anything else' leading to their selection, showing inadequate decisiveness and a lukewarm feeling towards their choice. Non-Emirati students, regardless of whether in STE or non-STE, were also twice as likely as Emiratis to select their field based on the belief that it suits their capabilities and skills. Comments from the interviews reflect similar thoughts:

'Emirati students typically don't know what they want to do.'

'They are not motivated, they have no idea what this is about, they have no clue what they are studying, they are not being informed, they have never made an informed choice with regard to their career or made a proper and informed educational choice.'

Interviewees called for more 'orientation and information' of students about options available to them in the STE labour market. Emirati women's limited interest in STE, and engineering in particular, can be partly attributed to lack of awareness of STE as a career option.[8] Students made aware of opportunities in the STE field in high school were much more likely to have considered STE as a field of entry. Moreover, STE and non-STE students were almost similarly likely to choose their field of study because they perceived it to be inventive and creative (around 5%). Given that, generally, STE fields are associated with creativity, innovation and applied disciplines, this may suggest that these characteristics are not cognisant in the students' interpretation of these knowledge domains. In fact, many STE students did not have a clear understanding of what studying in STE entails, as 20% of Emirati and 12% of non-Emirati STE students still did not know or were uncertain of what a scientist, engineer or scientist does. As an academic in one of the leading engineering schools in the country explained:

'They do not have a sense of what it means to be an engineer. Some are here because they are good in physics or because they could not go to medical school. In other words, because they are good in sciences, they assume they should enter engineering.'

4.2. *Role of family in students' programme selection*

Students were asked to identify the three most influential people for their decision regarding what educational programme to pursue (see Figure 2). Emirati students refer most frequently to their extended family, friends and then to parents for educational advice. It is to be expected that Emirati students rely on their extended family for advice considering the close family ties in the UAE, as many live with successive generations of the family.[9] On the other hand, non-Emirati students rely primarily on their immediate family (mother/father) for educational advice. This could be because non-Emirati students in the UAE are more likely to live only with their nuclear family and that their parents are more likely to be educated than those of Emirati students. As a result, they are potentially more likely to be involved in their daughters' education, given that higher parental education levels and academic familiarity have previously been closely linked to children's graduate education aspirations (McWhirter *et al.* 1996).

The qualitative analysis repeatedly pointed to the fact that, although students' personal interest in the field of study is of great importance in educational choice, the power of the larger community, as well as the family's approval, remain essential influences on all major decisions that women make. Despite this, based on the current findings, higher educational institutions in the UAE generally have not involved families in their students' education process, which potentially exacerbates parents' limitation in guiding their daughter's academic and career paths, leading to a case of 'the blind leading the blind'. With regard to engineering, the researchers were told that:

'[The] family factor plays a huge role, such that if a female chooses such a major, some, if not all of the family members, will try to convince her not to.'

It is also important to note that, as a result of educational institutions not involving parents in their daughter's education, female students were oftentimes prevented from engaging in extracurricular activities that may have enhanced their education, such as volunteering after hours, trips to conferences, networking events and physics club involvement. For instance, small-scale examples of the impact of family involvement in enabling Emirati female students to be actively involved in networking and educational events outside of school were found, specifically when families were openly invited to attend events with the student and persuasively informed of the importance of these events. Parents were usually concerned that the activity provided 'a proper setting for their daughter'. Hence, when parents granted 'parental permission', female students had a
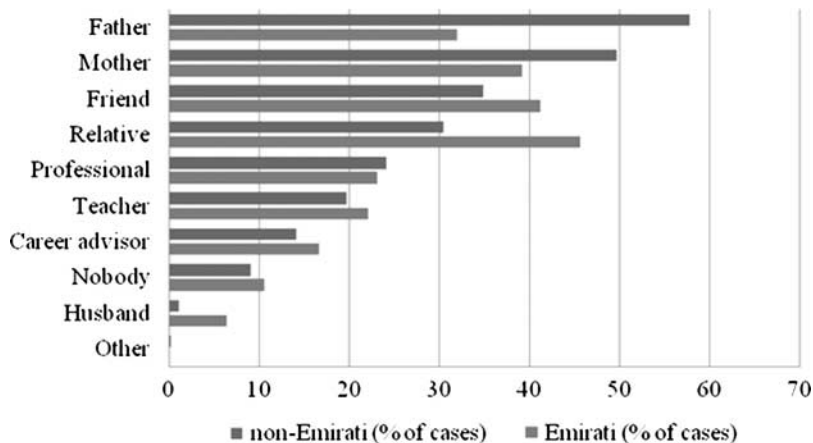

Figure 2.   Who students ask for advice from, regarding their field of study, by nationality (n = 1854). This was a multiple choice question – respondents were allowed to check up to three statements.

greater chance of participating in such activities and making educational choices closer to their interests.

4.3. *Reasons why students did not enrol in STE fields despite having considered it*

Among non-STE students, there were those who had considered applying for STE but had ultimately resolved against this option (see Figure 3). Two reasons dominated in the reasoning behind these decisions. First, interest in another field prevailed (23%). Second, students did not have the 'chance' to study STE. This was due to lack of university STE programmes in specific Emirates, coupled with restrictions on geographic mobility, which together prevented them from applying to STE. Other studies have also shown that low geographic mobility can prevent women's access to education and employment in the country (Baud and Mahgoub 2001). The quotes below further illustrate the salience of this problem, as reflected in the survey:

'There is only one local university in the whole country that provides STE with all disciplines.'

'Because the university that was offering that major was not in my city.'

'I wanted science but there isn't a wide variety to choose from in Abu Dhabi.'

'At my time I couldn't think of any good and very highly qualified university in Dubai.'

4.4. *Stereotypes of the engineering field*

Students were asked about the first word that came to mind when hearing the term 'engineer' (see Figure 4).[10] Astonishingly, the most common association was with fieldwork, construction, sun, dirt and desert (19%). In fact, it seems that, on many accounts, the image of an engineer was synonymous with that of a labourer, not generally a positive association considering the low social status of manual labourers in the country. The following comments from the survey further demonstrate this point:
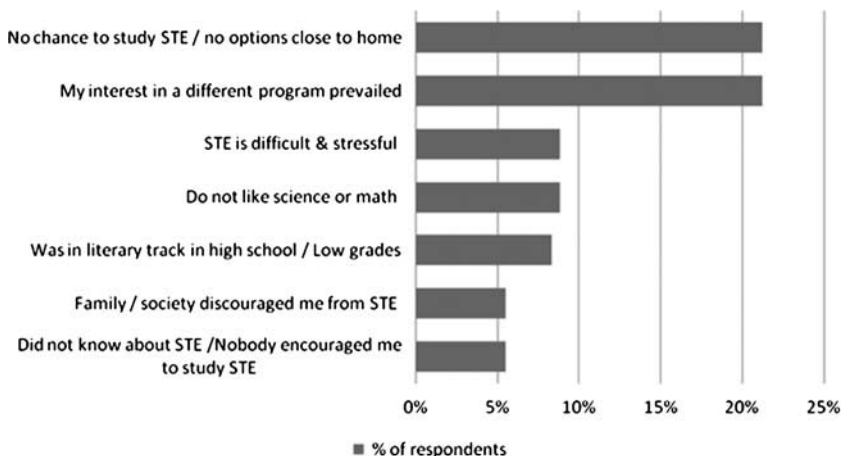
'Labor work. Men.'

'Sewage.'

Figure 3. Main reasons given by students for not applying for a science, technology and engineering (STE) field despite considering it (n = 353).
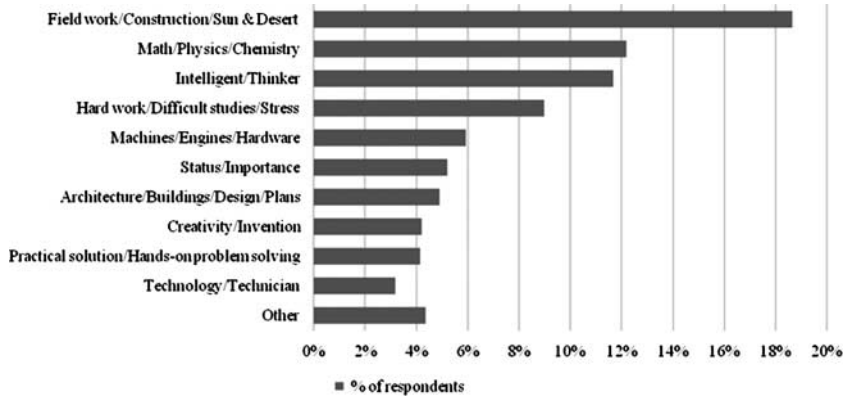
Figure 4. First word students that associate with the word 'engineer' (10 most common) (n = 1790). The category 'Other' includes responses such as the environment, certain nationalities (i.e. Indians), technologies (i.e. planes and cars) and names of well-known television actors who play roles as engineers.

'Man with construction helmet.'

'[O]utside. In the sun. In the desert. In August working on an oil rig.'

The second most prevalent connotation was with the subjects of maths, science, physics and chemistry, seen often as the extent of the application of the engineering field (12%). Students showed a narrow understanding of the many applications within engineering, believing the field to be exclusively for those passionate, and not intimidated, by these topics.

'Engineering requires a lot of complicated mathematics.'

'It is all about numbers, space, and distances which are complicated things.'

The third most established connection was with that of 'nerdiness' (11%). Engineers were perceived as 'heroes', 'braniacs' and 'brilliant' people with 'great minds'. Although at the outset this is a positive impression, the view of engineering as requiring an extremely elevated level of intelligence may make the field appear inaccessible to the large majority.

It is worth mentioning in this context the strong identification of engineering as a male-dominated field, with a powerfully 'masculine' image, similar to other depictions in the literature (Spence *et al.* 1975, Wolfe and Betz 1981). Also evident from the qualitative analysis was the expectation that engineering jobs would entail a mixed-gender environment (where men are the majority of employees), along with society and culture not supporting such careers:

'The national customs and traditions of the Arab countries strongly discourage a female from pursuing her goals in the engineering department.'

'Most jobs will be mixing males and females in one place and our culture in UAE does not accept that.'

Furthermore, the view of an engineer as an architect working on-site was also prevalent (5%), with some students buying into the stereotype that much of what constitutes an engineer's daily work is 'dirty' work, not requiring much brain power. However, female engineers who were interviewed clarified that this was not necessarily the typical case:

'The stereotype for an engineer from the movies where you think that every engineer is an architect and every engineer has to go to site construction and that they are always with their maps in the construction site, we don't do that.'

'Once you understand what is engineering about, then you see that there are many positions that do not require any site involvement to some extent...People do not know what is engineering about.'

5. Conclusions

This study is the first to perform a thorough assessment of the factors that encourage and inhibit women's engagement in STE fields in the UAE. The research is based on the assumption that qualifications in these domains are critical for sustaining the transition to a knowledge-based economy. In order for policy guidelines to successfully instigate a broader involvement of women in these fields, it is imperative that strategies reflect the local context. This is critical, since a knowledge-based economy can only thrive when the indigenous context is addressed in programmes aimed to build local capacity (Abu Dhabi Council for Economic Development 2008, Dubai Government, 2009).

Although there is certainly a need to stimulate students' interests in these fields on a wider basis, there needs to be greater awareness of the fact that the educational choices of women in the UAE are often made based on consultations with the family and community. Consequently, there is a need for educators and university-level management to further involve families in female students' educational and career development. Establishing a communication system between universities and families and providing parents with relevant information about educational opportunities would be a step in this direction. Parents should be better informed about academic activities that their daughter is involved in and conferred with regarding prospective career opportunities early on, in order to render them better equipped to offer advice on suitable careers. This would allow female students to make choices closer to their interests and inclinations, as well as reduce some of the inherent biases that families may have regarding STE careers.

Furthermore, most students appear to have a limited perception of what scientists, technologists and engineers do in their professional lives. As a result, initiatives to cultivate awareness and curiosity about STE professions would contribute to forming a clearer understanding of what careers in STE encompass. Schools and media should promote the accomplishments of women professionals in STE to minimise persisting gender stereotypes in these domains. Additionally, messages that resonate with Emirati females, illustrating STE as a promising career that propagates the country's interests should be developed and tested. Although many positive efforts exist in this regard, they are not mandated widely across the Emirates and are not cohesively coordinated. Initiatives to move towards a knowledge economy should implement a directional strategy that percolates to the local levels, to increase familiarity as well as address negative stereotypes of the engineering field.

Increasing the availability of STE university programmes across all the Emirates is a necessary requisite for greater STE enrolment. Although other reports have touched upon the lack of STE programmes in the region,[11] few have emphatically expressed the barrier that such a deficiency forms by hampering female students' enrolment in these fields. A greater emphasis on investment in such programmes would ensure wider access to these fields, especially when considerations for low geographic mobility of female students (due to transportation and cultural considerations) are made. Hence, it would be advisable for education policy-makers to work closely with universities and the local community to find suitable solutions that respond to the educational needs within each Emirate.

Finally, although it is expected that no single intervention can alter women's STE involvement, it is hoped that a gradual implementation of policy changes at different levels may contribute to a greater realisation of the unfulfilled potential of women in these fields. It also opens up opportunities for further research on various related topics, such as the institutional barriers to STE enrolment, the influence of high school education on students' aspirations, as well as the factors that influence the retention of women in STE fields.

Notes

1. The fields of study included in this category are generally talked about in the literature as science, technology, engineering and mathematics.
2. Almost 70% of the Emirati population is below 24 years old (Government of Abu Dhabi 2008).
3. More details on the questionnaire, as well as other key findings of the research, can be found in Ghazal Aswad *et al*. (2011) and Vidican *et al*. (2011).
4. In order to gain a better understanding of wealth status, students were asked to identify their family as poor, middle class or rich.
5. The data collected from the questionnaires were analysed using SPSS software.
6. Data collected from the interviews were analysed using NVivo software.
7. The exact statements from the students and interviewees (despite potential grammatical errors) were kept to preserve the integrity of the responses.
8. Such lack of knowledge about STE has been found in other nations (McIlwee and Robinson 1992, Gale 1994, Francis 2002, Bagilhole *et al*. 2005, Alpay *et al*. 2008).
9. Al Qassimi and Farid (1996) show that the family size in the UAE is large, with an average of 7.28 persons. Other studies of 'non-Western' cultures also substantiate the importance of the extended family in students' choices and school achievement (Chao 2001, Christina 2008).
10. The question used in the questionnaire was open-ended, framed as: 'What is the first word that comes to your mind when you hear "engineer"?' Responses were coded according to the most common themes apparent in the sample.
11. MHESR (2007) highlights 'the need to…increase the number of (STE) programs, and assure the rigor of the curriculum to meet international standards'. Fox and Hayward's report (2008) also states that there is a noted lack of science and engineering degrees in Dubai.

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