
Saudi women: Opportunities and challenges in science and technology

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To cite this article:

Samira Ibrahim Islam. Saudi Women: Opportunities and Challenges in Science and Technology. *Education Journal*. Vol. 3, No. 2, 2014, pp. 71-78. doi: 10.11648/j.edu.20140302.15

Abstract: Women inequality is one of the issues used to criticize the policy in Islamic World. Social inequality fueled the outbreak of the Arab Spring. Ongoing plight across Arab counties had not achieved successful resolution. King Abdullah bin Abdulaziz focused on modernizing the deeply conservative Saudi society, governed by Sharia'a law, through Science diplomacy. Under his leadership, the kingdom's diplomatic relation with the developed countries was empowered allowing transfer of modern scientific education equally for both men and women. This included the overhauled of the existing scientific educational & research institutions, introducing new institutions with state of the art scientific facilities, promoting technology exchange of various research programs with international scientific institutions, establishment of the first mixed-gender post graduate university, involving international faculties & students, scholarship program allowed male & female students to study at developed countries. The gender gap in university registration, Saudi Arabia ranks no. 25th. Saudi women are vigorously pursuing higher education especially in science at a rate greater than Saudi men & Western women. They are becoming pioneers in a variety of fields, most prominently in science and research, assigned in different types of posts which were not allowed, such as work in industry, leading decision making government, private sector posts & Shura cabinet members. They are receiving international awards, granted patents for their ideas and innovations. King Abdulaziz first class Saudi medal awarded to women scientists.

Keywords: Saudi Women in Science, King Abdullah of Saudi Arabia Empowering Women, Science Education

1. Introduction

The topic of Saudi women is a complex and controversial. Saudis live under the system of Shari'a (Islamic) Law, which is being criticized by the West as being repressive of women's rights. However, some Saudi women (and men) are content with the laws under which they live.

The Saudi government has made a considerable effort to promote gender equality, and to ensure women's equal access to education. In September 2000, the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) was signed and ratified, though with some reservations. [1]

The education sector of the Kingdom of Saudi Arabia is passing through a new era because of its young and growing population and prospering knowledge-based industry. The Kingdom has recently stated a complete overhaul of its educational system at a cost of US\$3.1 billion, which made Saudi Arabia the 8th highest education spender in the world [2]

To promote a knowledge-based economy and move from

oil to a worldwide centre for high-technology research, Saudi Arabia has announced a research initiative called 'Aafaq' or Horizons. The 25-year plan is intended to improve higher education opportunities for women, boost scientific research and tackle the country's shortage of scientists in critical fields. This plan will produce technical human resources that will be the workforce for science-based economic development and will help in turning brain drain that threatens science development into economic gains [3]

The percentage of women receiving education has increased since the 1960s, although women are still prevented from taking, courses in certain fields, such as engineering, journalism and architecture. According to the World Bank report, women students in higher education in Saudi Arabia out-number those in Jordan, Lebanon, Tunisia, Palestine, West Bank and Gaza.

Due to the government's commitment to girls' education, the number of girls' schools increased faster than boys' schools. According to the World Bank, in the year 2008, the literacy rate for females ages 15-24 was 97 % [4].

In 2009, an expert in administration became the first woman minister in Saudi Arabia. Nora bint Abdullah al-Fayez, was appointed deputy education minister in charge of a new section of the Ministry of Education responsible for female education. In addition, the Saudi government now offers one of the world's largest scholarship programs for women. With the benefit of scholarship aid, thousands of women have earned advanced degrees, including doctorate degrees from Western universities [5].

2. Saudi Women and Higher Education

Government funding for higher education was particularly generous during the period from 1983 to 1989. In those six years, the number of university students increased from approximately 58,000 to about 113,000 (95 % increase). Even more dramatic was the increase in the number of women students at the university level during the same period: from 20,300 to 47,000 (132 % increase) during

the same period. [6]

In 2006, a total of 636,245 (268,080 men and 368,165 women) students were enrolled in higher education (Table 1). The gross enrollment rate for women was 36.1% compare with 24.7 % for men. [7]

Currently, women account for 58% of all Saudi university students, and this rate is expected to increase with the opening of new colleges and universities across the Kingdom. Saudi Arabia now has 300 women's colleges, and that number is set to increase. The government has allocated SR150 billion for this initiative in the 2011 budget. [8]. In 2013, the Saudi government allocated SR204 Billion (US\$54,4 Billion) for education from its national budget [9].

To improve the quality of education, the Ministry of Higher Education launched several programs such as: major quality initiatives, including plans to establish research excellence centers, promoting creativity among faculty members, translation of important textbooks, and students' counseling programs.

Table 1. Saudi students enrolled in higher education in 2006

| Degree | W/M % | Women | Men | Total |
|----------------------|---------|---------|---------|---------|
| BSc | 64.5 % | 340.657 | 187.489 | 528.146 |
| MSc | 43.17 % | 4.217 | 5.551 | 9.768 |
| PhD | 64.35 % | 1.117 | 1.293 | 2.410 |
| Intermediate Diploma | 30.15 % | 21.769 | 72.199 | 93.968 |
| High Diploma | 20.74 % | 405 | 1.548 | 1.953 |
| | 57.87 % | 368.165 | 268.080 | 636.245 |

3. Government Commitments to Women's Education

Since 1960 women's education has been a significant goal of Saudi governments. It was the first time the government managed to open official primary schools for girls, which represent a significant breakthrough. The government took this step despite resistance by the conservatives who finally agreed on the condition that they will be in-charge with full authority to all girls' education from primary schools up to university colleges. They were at a ministerial level named "General Presidency of Girls' Education" (GPGE), which worked parallel to but independent with the Ministry of Education, who was responsible only for boys' education. In the year 2003, The GPGE was cancelled and the girls' education pre-university levels were merged with the Ministry of Education while the university level was merged with the Ministry of Higher Education [10].

In General, the Custodian of the two Holy Mosques, King Abdullah bin Abdulaziz Al Saud is building knowledge based society. This is manifested in the recent extra-ordinary investments in Saudi Arabia's education system, which has increased access to university education, exposed young Saudis to education and cultures abroad, and drawn international talents to Saudi Arabia to both teach and conduct research. The bravery and breadth of the King's initiatives are

clear indications that he recognizes the importance of highly educated people in a modern Saudi Arabia.

The King Abdullah bin Abdulaziz Al Saud Project for General Education Development (Tatwir) was launched in 2009. This project has a budget of SR9 Billion (US\$2.4 Billion) and will be implemented over the next six years. Its goals are to train more than 400,000 teachers in school management, educational supervision, curriculum development, computer science, self development skills and the application of modern technology to the educational process. In addition, this project will introduce extracurricular activities for developing the intellectual, creative and communicative skills of students [11].

The preparatory year for university entrance is a compulsory measure adopted by the Ministry of Higher Education in all major universities in the Kingdom to enhance the knowledge of women students planning to take university degrees in the fields of medicine, business administration, computer sciences and agriculture [11]. The one year course covers English, mathematics, computer science and communication, in addition to courses in health awareness, civic education and self learning.

In addition, the government also provides financial assistance for women students and incentives in the forms of allowances throughout their years of study

The overall success of women's education has required major changes in the conduct and actions of the government,

policy officials and educational authorities. It is clear however, that more must be done by the government to provide women equal opportunity in education, to ensure that they benefit from the eradication of illiteracy and the opportunity for a full education, as well as vocational training.

4. Government Investments in Higher Education

King Abdullah's reign is considered as the golden era for women's education. Since he assumed the throne in 2005, he has made educating Saudi women as his top priority. Indeed, Saudi Arabia's current investment in higher education has amazed the Arab world.

In the past, Saudi Arabia lagged behind GCC countries in women's education, but now, female illiteracy is significantly reduced, practically eliminating it among women ages 15 to 24, according to the World Bank.

Within a decade, the number of government universities has four times doubled, from 8 to 33.

4.1. King Abdullah University for Science and Technology (KAUST)

KAUST is a graduate-level research university, the realization of the vision of King Abdullah, to promote the advancement of science and technology in Saudi Arabia. The university opened in September 23, 2009 with a US\$10 Billion endowment and financial commitments from most major Saudi corporations.

Its core campus, sited on more than 36 square kilometers (14 square miles), is located at Thuwal on the Red Sea, and includes a marine sanctuary and research facilities [12].

This is the first co-educational university campus in Saudi Arabia. Women are allowed to mix freely with men and to drive on campus and they are not required to wear veils in the coeducational classes. Saudi authorities are hopeful that this mixed-gender center will help modernize the Kingdom's deeply conservative society [13].

KAUST organizes interdisciplinary collaborative research teams of faculty and students, without regard to disciplinary boundaries, across three academic divisions: (1) Chemical and Life Sciences and Engineering; (2) Mathematical and Computer Sciences and Engineering; and (3) Physical Sciences and Engineering. The university offers two graduate degree programs in the various fields: a Master of Science degree (18 months) and a Ph.D. program (3-4 years), involving original research that culminates in a dissertation.

4.2. Princess Nora Bint Abdulrahman University

The University was established under the Royal Directive no. 3139/MB dated 18 /4/1427H, stipulating the approval of establishing a university for girls in Riyadh under the patronage of the Ministry of High Education to which the 23 colleges of girls located in Riyadh district (previously

related to the Ministry of Education) were associated.

A SR19 Billion (US\$5 billion) institution located just outside of Riyadh, Saudi Arabia. Princess Noura bint Abdulrahman University is a women-only educational campus with a capacity of approximately up to 50,000 students. The campus is divided into several colleges, specific units, including a separate medical research campus and hospital area. It also includes student recreation and housing facilities, as well as recreation and housing for faculty and staff. The entire campus is connected and accessible via an elevated monorail system incorporating 16 elevated train stations [14].

On April 2012, a total of 5000 women graduated; out of which 142 were post graduate degrees.

4.3. King Abdullah bin Abdulaziz Scholarship Program (KASP)

Saudi King Abdullah implemented the King Abdullah Scholarship Program in late 2004 to increase the number of Saudis, especially women, attending Western universities. The government also issued scholarships for Saudi students to attend English language schools to prepare for university studies. [15]

The goal of this program are to prepare Saudi students to compete in scientific research and other fields on an international level and become an important source of highly qualified faculty for Saudi universities as well as professional staff for the government and private sectors. Administered through the Saudi Ministry of Higher Education, KASP is one of the most generous scholarship programs in the world, providing financial support for the following:

- Monthly stipend
- Full tuition and fees paid directly to the educational institution
- Cost of attending conferences, symposia and workshops
- Annual plane tickets for the student and his/her family
- Expenses for scientific trips
- Allowances for books and clothing
- Financial support for dependents and spouse or mahram
- Medical insurance

The scholarship program allows Saudi students to go to the world's best universities to pursue bachelor's, master's and doctoral degree. The Kingdom spent more than US\$2 billion a year on the program, according to some reports [16]. Between 2004 and 2008, an estimated 42,000 Saudi government scholarship students attended universities, mostly in the United Kingdom, the United States, Canada and Australia. In 2009, that number rose to 52,000 students. Scholarships are also awarded to Saudi students to attend domestic universities.

As of 2010, KASP allowed more than 70,000 students to study and acquire the knowledge and skills meanwhile they serve as "cultural representative" of Saudi Arabia to more than 25 countries in the world [15]. Out of these students, an

estimated 15,616 students (25 percent of whom are women) were studying for undergraduate and postgraduate degrees in the United Kingdom (Table 2). Among them, more than 5000 are studying in a scientific discipline.

In order to attend foreign universities, Saudi students must be proficient in English. Language schools prepare Saudi students who do not have good IELTS or TOEFL scores to achieve passing results. The Ministry of Higher Education provides scholarships for students to attend English language schools during their scholarship period. Tuition and living expenses are the same for language school scholarships as university scholarships. The average attendance at a language school is about one year [15].

5. Results

The education landscape in Saudi Arabia has changed dramatically in recent years. There are now 24 government universities and their associated 102 government teacher colleges, in addition to private colleges and universities [15]. Some of the Saudi universities do remarkably well on international rankings. Webometrics of World Universities (produced by Cybermetrics Lab) rank King Saud University

of Riyadh, founded 1957, the best in the Arab world, and number 197 in the world. Other institutions in the top 1000 are King Fahd University of Petroleum and Minerals, Dhahran, at number 303; Imam Muhammad bin Saud Islamic University, Riyadh, at number 636; and King Faisal University, Dammam, at number 993 [17].

More than ever, women are taking the lead in education (Figure 1). World Bank and Saudi government figures show that the ratio of women to men in tertiary enrolment is consistently high. According to both World Bank and the Saudi government's data, in 2010, 58% of all students enrolled at universities were women.

The Kingdom has seen an influx of women students taking an interest in science nationally (Figure 2) and internationally.

In 1989 the number of graduates from all of the Kingdom's colleges and universities was almost the same for men and women: about 7,000 each. During the years 2008 – 2010, the percentage of women graduates out-numbered men in all major fields of study except agriculture and engineering (Figure 3). In 2010, 63.42% of all graduates were women [15]

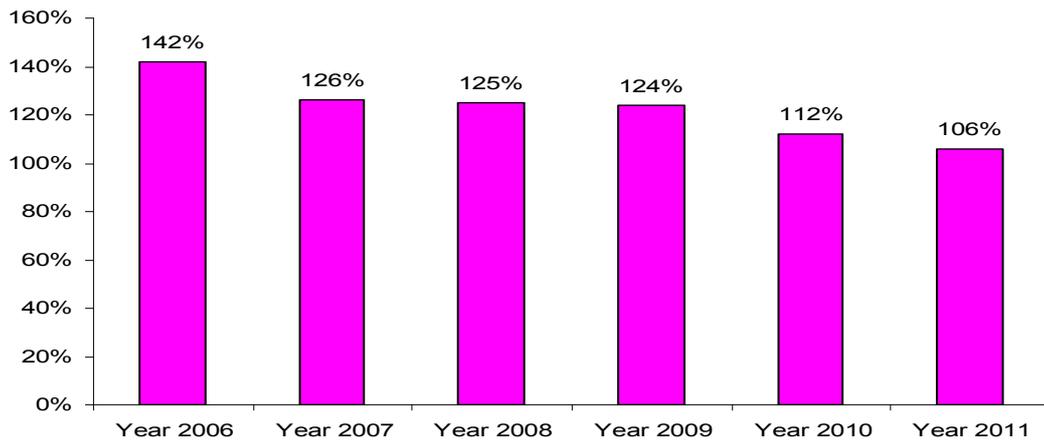


Figure 1. Ratio of women to men tertiary enrolment in Saudi Arabia by year

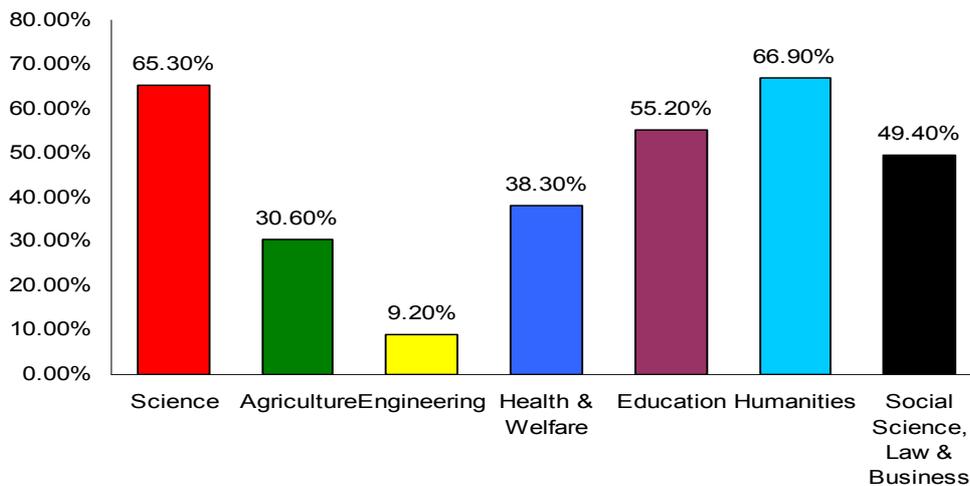


Figure 2. Women's share of enrollees in tertiary education in Saudi Arabia during the year 2011 by field of study

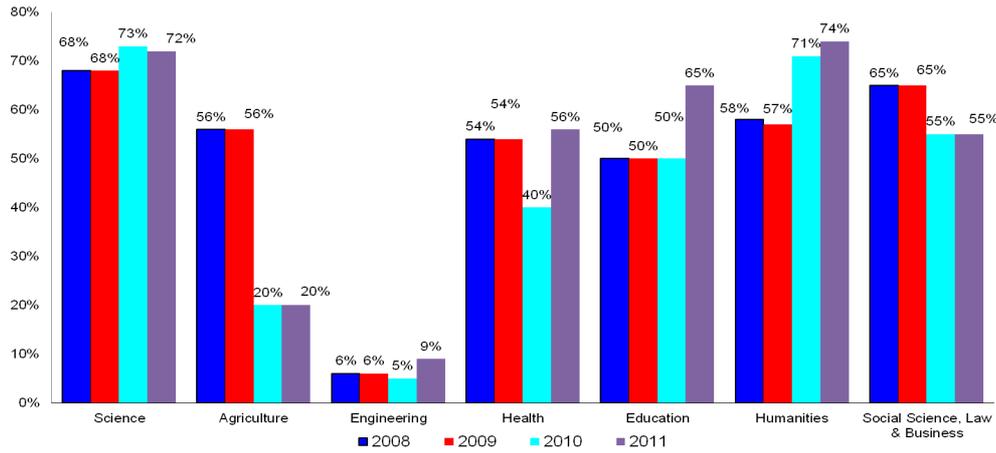


Figure 3. Women's share of graduates in tertiary education in Saudi Arabia in the years 2008- 2011 by fields of study

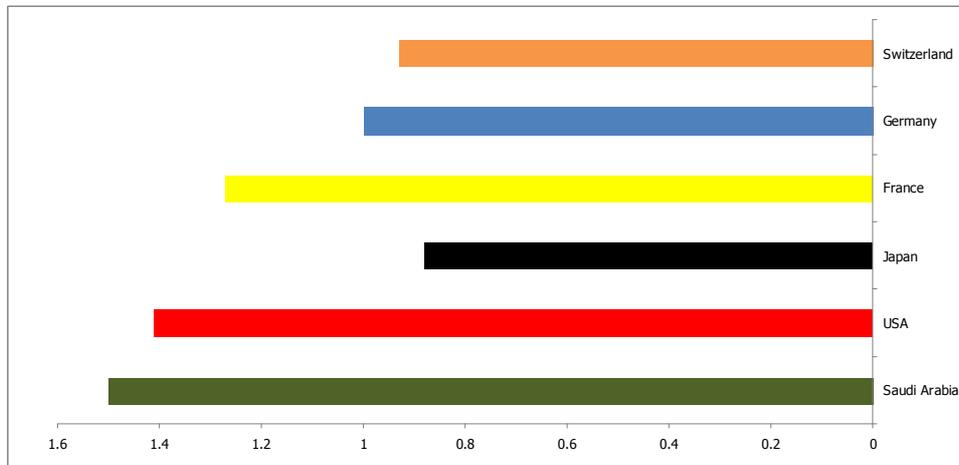


Figure 4. Women tertiary level enrolment over men

Saudi women are vigorously pursuing higher education at a rate greater than that of Western women. According to 2009 Global Education Digest of UNESCO and the 2009 Global Gender Gap report, the ratio of women to men in higher education in the Kingdom was 1.5, higher than that of the USA (1.41), Japan (0.88), France (1.27), Germany (1.0) and Switzerland (0.93) (Figure 4). Saudi Arabia ranks 25th among countries, in terms of the gender gap in university registration. In this regard, the Kingdom also ranks higher than advanced countries such as the USA and Germany. Saudi women are becoming pioneers in a variety of fields, most prominently in science and research. They are also receiving international awards and being granted patents for their ideas and innovations (15).

6. Research and Development (R and D)

Saudi Arabia ranked fourth among Organization of Islamic Countries (OIC) member states in terms of scientific and technological productivity (measured by published research between 1995 -2005) [15, 18]. Among GCC States, Saudi Arabia has the highest numbers of scientific and technical journal articles published in the fields of

physics, biology, chemistry, mathematics, clinical medicines, biomedical research, engineering, technology and earth and space science (Table 2) [20].

Table 2. Scientific & technical journal articles published in GCC states

| 2009 | 2008 | 2007 | 2006 | Arab States |
|------|------|------|------|-------------|
| 36 | 43 | 48 | 41 | Bahrain |
| 70 | 68 | 73 | 67 | Iraq |
| 383 | 412 | 344 | 285 | Jordan |
| 710 | 621 | 589 | 558 | KSA |
| 214 | 240 | 242 | 257 | Kuwait |
| 256 | 280 | 238 | 250 | Lebanon |
| 64 | 60 | 48 | 42 | Qatar |
| 72 | 67 | 80 | 62 | Syria |
| 265 | 256 | 214 | 230 | UAE |
| 25 | 13 | 18 | 24 | Yemen |

6.1. Saudi Women in Research

According to a recent report by UNESCO, the number of researchers worldwide measured in full-time equivalents (FTE) has increased from an estimated 5.8 million in 2002 to

7.1 million in 2007. [20]

Globally, women represent slightly more than one-quarter of all researchers (29.5%). In 37% of those countries, with available data, women represent less than one-third of the population of researchers. Only about 15% of those countries have achieved gender parity while only a handful of them have more women researchers than men [20]. Women in the OIC represent around 26.8% of the total researchers, slightly lower than the world average [21].

In Saudi Arabia, 19.5% of all Saudi researchers are women. This rate is low but is higher than Germany (12%), Japan (12%) and Korea (11%). [3]

7. Government Institutions That Support Research, Resources and Projects

7.1. King Abdulaziz City for Science and Technology

KACST is both the Saudi Arabian national science agency and its national laboratories. The science agency function involves science and technology policy making, data collection, funding of external research, and services such as the patent office

Objectives:

1. Propose a national policy for the development of science and technology and develop strategies and plans necessary to implement them.
2. Execution of scientific research programs for development in the Kingdom.
3. Fostering of the private sector to develop agricultural and industrial research.
4. Enhancement of various research programs between the Kingdom and international scientific institutions for the purpose of keeping abreast of scientific advances, whether through scholarships or joint research.
5. Offering of scholarships and training courses in the field of scientific research. KACST also awards scholarships to individuals and establishments to conduct applied scientific research.
6. Coordination with governmental organizations, scientific institutions and research centers in the Kingdom for the purpose of research and data exchange

Since its establishment in 1977, KACST had been carrying out its mission by promoting S & T in the Kingdom by coordinating and cooperating with various academic institutions, private agencies and government research organizations and in pushing local experts to undertake research that will enhance the Saudi the society. [22]

The scientific funding provided to the scientists of the universities and research institutions Kingdom wide is available from the Directorate of Research Grants Programs. In the year 2011, KACTS funded a total of USD108,884,875 research projects summarized as follows (Table 3):

Table 3. KACST funded research until 2011

| Field | Number of Research projects | Total fund in USD |
|--------------|-----------------------------|-------------------|
| Agricultural | 105 | 27,761,237 |
| Humanities | 2 | 74,320 |
| Medicine | 122 | 33,120,752 |
| Science | 67 | 12,798,481 |
| Engineering | 195 | 35,130,085 |

8. Challenges for Saudi Women to be Addressed

It is hard to envisage the possibilities that open up when there are almost no budgetary restrictions that will interfere in the development of higher education. Where will all these lead Saudi Arabia?

One of the primary & huge challenges is certainly the opening of job opportunities to educated women, but this is not all. Can contemporary education be separated from a contemporary culture and still accomplish relevant results?

At the university level, the fields of education and training for women are limited as the specializations allowed for them do not correspond to the needs of the labor market. Architecture, science and technology, engineering and agriculture, for example, remain fields dominated by men.

What destiny awaits the 50,000 women from Princess Noura University when they begin to graduate and find themselves in a country where women do not have the full freedom necessary to pursue a professional career? Although Saudi women have already been granted the right to own a property, run their own business, have independent status and currently the right to vote, still few have the independence to leave their home without a male escort from their immediate family [23]. Will all of these graduates be happy with limited contingency? How will Saudi Arabia benefit from these educated women, who are considered important and well-prepared citizen?

Furthermore, when the 130,000 scholarship students return to Saudi Arabia from overseas study & training, what advancement will they have in Saudi Arabia? After being exposed to so many different cultures and ideas, will women easily re-integrate into a more traditional and restrictive society? Will these young professionals be content to abandon the freedoms and advancements that they have while abroad?

It is easier to believe that Saudi students will adjust to the customs of the world outside where they can choose to maintain their customs or adjust to new ones than it is to expect international faculties and students to accept the limitations that come with moving to Saudi Arabia. How long will international scientists be willing to remain in a society that places limitations different to what they are used to on their personal lives and their professional opportunities?

Education cannot be separated from the larger socio-political circumstances where it takes place. When successful, education encourages new ideas, new thinking, new actions and new

opportunities. But in the context of the Saudi conservative society, which accepts change neither easily nor quickly, is it challenging to reap the benefits of education.

Currently, the Saudi Arabian education system is producing a large number of educated women graduates seeking employment in fields that the economy needs. More than 90% of the Saudi women actively participating in the workforce hold a secondary qualification or a university degree. However, such qualification does not guarantee employment: 78.3% of unemployed women are university graduates, and more than 1,000 have a doctorate degree [24].

The public sector is the largest employer of women, and Saudi women currently make up around 30% of government employed women [24]. Approximately 95% of working Saudi women is in the public sector out of these, 85% in education, in both teaching and administrative positions, 6% in public health, and 4% in administration [25]. Only 5% of working Saudi women is employed by the private sectors, and the majority of them work in a narrow range of jobs such as private business and banking.

Overall, Saudi women's current participation rate in the workforce is only 14.4% (2010), one of the lowest in the region. For comparison, the UAE's national female participation rate is 59%; Kuwait's is 42.49%, Qatar's is 36.4% and Bahrain's is 34.3%. In addition, the 34% unemployment rate for Saudi females in the labor force in 2013 was almost five times higher than that for Saudi males [17]. Clearly much more must be done to remove barriers to professional opportunities for this new generation of well educated Saudi women.

9. Conclusion

In recent history, the Kingdom of Saudi Arabia, which enforces a strict version of Shari'a law, has been resistant to change. The constraints on Saudi women in particular have long been out of line with those on women in other Muslim countries. When in public, for example, Saudi women and girls must wear the hijab, a traditional Muslim head covering for women, and an abaya, a full black cloak. Women are not permitted to drive a car, motorbike or ride a bicycle. Women are forbidden to ride public buses in most of the cities and, where it is permitted, they must sit in the back. The vast majorities of Saudi institutions have been and continue to be segregated by sex. A notable exception is the King Abdullah University for Science and Technology, founded just three years ago, the first co-educational post graduate university in the country [13, 26].

Educational reforms begun in 1960 and accelerated in recent years under the leadership of King Abdullah have given Saudi females equal access and support for education, with dramatic results. In 2012, more than half of all university students, 58%--were women. In 2010, the ratio of women to men in higher education was 1.5, higher than in the USA, Japan, and several European countries. Saudi women are also pursuing the sciences in ever increasing numbers, at universities both in the Kingdom and abroad.

But educated Saudi women are under-utilized in the economy of their homeland. Scientific fields in Saudi Arabia continue to be dominated by men. That also remains the reality in the USA and European nations, but some fields important to the modern economy, such as agriculture, architecture, and engineering are largely unavailable to women in Saudi Arabia. Moreover, only 14.4% of Saudi women currently participate in the workforce, the lowest rate in the region, and 78.3% of unemployed women hold university degrees. The government hires women, predominantly in education (85%), but as yet, the private sector generally does not. Only 5% of jobs currently held by women are in the private sector.

Although there remains strong resistance to women's social freedoms, rights, and job opportunities in Saudi Arabia, there is reason for optimism about the future for Saudi women. In 2004, King Abdullah bin Abdul Aziz al-Saud issued a decree encouraging women to seek jobs in fields that had previously been reserved for men, such as law and business. That was one of many signals he has sent suggesting that Saudi Arabia cannot progress economically or socially without giving more power to women [5]. More than 22,000 commercial licenses have been issued to women, many of whom run their own beauty, furniture and fashion businesses. Women are also beginning to realize the importance of investments; women now own nearly 20 percent of mutual funds. It is believed that about SR15 billion in cash assets are owned by women and stored in current accounts [27]. Women also have a strong presence in medical fields; about 40% of Saudi doctors are women [8].

Probably the biggest change for women in this conservative kingdom in recent years occurred in September 2011, when King Abdullah granted Saudi women the right to vote and in 2013 appointed 30 women (20%) as members of the consultative Shura council. "We refuse to marginalize the role of women in Saudi society," the king declared in his address announcing this change. Women certainly remain marginalized in Saudi Arabia, but given the combination of King Abdullah's futuristic thinking and boldness, Saudi women's demonstrated strength and vigorous pursuit of education, and the winds of change in the Middle East, it is easy to imagine many more Saudi women serving as successful doctors, teachers, and administrators, but also as physicists, engineers, lawyers and entrepreneurs, commonly driving themselves to work.

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