

The Moroccan and Canadian experience in promoting science and mathematics to stimulate talents in MENA students and in stimulating talents

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Abstract

From the perspective of sharing information about programs focusing on the identification of potential scientific talents, especially in the Middle East and North Africa (MENA) region, Professor Ghazzali will speak about her experience as a Moroccan scientist and as holder of the Natural Sciences and Engineering Research Council-Industrial Alliance Chair for Women in Science and Engineering in Quebec. Many initiatives in science and mathematics will be presented.

The Moroccan and Canadian experience in promoting science and mathematics to stimulate talents in MENA students

Nadia Ghazzali

1. Initiatives for students talented in mathematics and science in the MENA region

Currently, I am assisting in the creation of the Moroccan Association of Women Engineers and Scientists, with the collaboration of Minister Delegate Ms. Nouzha Chekrouni. She will also be involved in the first “Rencontre des femmes scientifiques méditerranéennes” (REFSCIMES, 2010; Mediterranean Women Scientists Meeting), which will be held in December 2010 in Algeria. Recently, I started collaborating with the Arab Science and Technology Foundation (ASTF) on the planning of an upcoming International Network of Women Engineers and Scientists (INWES) Regional Meeting. In December 2010, the World Federation of Engineering Organizations (WFEO) will organize the Young Engineers Forum “Leadership and Ethics Empowerment for Young Engineers” in Tunisia.

The Hassan II Academy of Science and Technology of Morocco is “a place of high thinking, where men and women whose talent, enlightenment and wisdom have earned them a prominent standing within the international scientific community to foster moral serenity in society and to achieve the material prosperity of the nation as well as its intellectual advancement by pondering on how to provide mankind with enlightenment and guidance in its effort to usher in a new era.”¹ The Hassan II Academy of Science and Technology is a dynamic organization that seeks to achieve the followings objectives:

- Promotion and development of scientific and technical research
- Formulation of a national policy for scientific and technical research
- Evaluation and funding of scientific and technical research programs

¹ Kingdom of Morocco, “Hassan II Academy of Science and Technology.” <http://www.academie.hassan2.sciences.ma/an/presentation/presentation.php>, Accessed on December 8, 2010.

- Integration of scientific and technical research activities in the social and economic environment at national and international levels.

The Academy includes six colleges. I belong to the College of Modeling and Information Sciences, which includes faculties of mathematics, science and techniques of information, communication, computer science, and more. My role is to provide advice and to collaborate with researchers in Morocco, in order to stimulate research activities (e.g., the publication of scholarly books and journal articles, and the hiring of highly qualified personnel).

Since 2006, the Hassan II Academy of Science and Technology has organized several scientific events for the benefit of youths, pupils, and students. Among these events are conferences, meetings with eminent scientific personalities, onsite visits, expositions, and showings of scientific movies followed by discussions and debates. In 2010, the annual plenary sessions of the Academy discussed “Maladies émergentes et re-émergentes et menaces pandémiques” (“Emerging and reemerging diseases and pandemic threats”); in 2011, they will celebrate the International Year of Chemistry.

2. Students from the MENA Region in universities in Quebec who continue to study sciences

My statistical study, “Profil des inscriptions des étudiants étrangers aux trois cycles universitaires au Québec de 2001 à 2007” (“International students’ profiles at undergraduate and graduate levels in Quebec from 2001 to 2007”) was published this year. Among the students from the MENA region who are registered in Quebec higher education institutions, the largest number seek a bachelor’s degree in applied science: 569 students in 2001 and 875 in 2007 (an increase of 53.78%). There has been an increase at all levels between 2001 and 2007, chiefly in pure science (an increase of 94.6% for the bachelor’s degree) and in applied science (an increase of 130% for the master’s degree). Women students chiefly experienced increases of 107% for the bachelor’s degree in pure science, 127% for the Ph.D. degree in applied science, and 135% for the master’s degree in applied science. The two other fields with the most students are human sciences and management.

The largest number of Jordanian students registered at all levels in science and engineering in Quebec seek the bachelor’s degree in applied science: 42 students were registered for this degree in 2001, 34 in 2007. But even in this field, there have been decreases of 19.05% for the bachelor’s degree and of 20% for each of the master’s and Ph.D. degrees. The main decrease is for the Ph.D. degree in pure science: 66.67%. Among women students, there has been a decrease in those seeking the bachelor’s degree: Registrants in pure science fell by 66.67% and in applied science by 71.43%. However, between 2001 and 2007 there was an increase of one woman student at the master’s degree level for each of pure and applied science and one for the Ph.D. degree in pure science. The field with the largest proportion of students is applied sciences, with 57 students in 2001 and 46 in 2007 (a decrease of 20%), followed by human sciences and management.

The largest number of Tunisian students registered at all levels of science and engineering in Quebec was 153, who sought the bachelor’s degree in applied science in 2001; the number fell to 141 in 2007 (a decrease of 7.84%). The largest increase from 2001 to 2007 was 175%, for the master’s degree in pure science. The largest decrease was 42.3%, for the bachelor’s degree in pure science. Among women students, the main increases were 111% and 150% for the master’s degree in applied and pure sciences, respectively. The largest number of women students registered in 2001 was 12, for the bachelor’s degree in applied science; in 2007, 19 women sought the master’s degree in applied science. The field with the most students was applied sciences, in both 2001 and 2007. There was a small increase of 4.44% in the number of students registered in pure science from 2001 to 2007; the number

grew from 45 students to 47 over those years. Applied science saw an increase of 2.20%, from 227 students in 2001 to 232 in 2007.

The largest number of Moroccan students registered in science and engineering at all levels in Quebec sought a bachelor's degree in applied science. The number rose from 226 students in 2001 to 291 in 2007 (an increase of 28.7%). Between 2001 and 2007, the proportion of Moroccan undergraduate students increased while the proportion registered at the graduate level decreased. The largest increase was 73.9%, for the bachelor's degree in pure science. The largest decrease was 60%, for the master's degree in pure science. For women students, the largest increase was for the bachelor's degree in pure science, 62.5%. The largest number of women students was in the bachelor's degree in applied science, with 45 students in 2001 and 63 in 2007 (an increase of 40%). The largest decrease was 83.3%, for the Ph.D. degree in pure science. The number of women students in applied science grew from 319 students in 2001 to 348 in 2007 (an increase of 9.09%).

Among all the international students from 194 countries who were registered in science and engineering programs in Quebec, the country most represented is France, with more than 30% of international students. The proportion of French students increased from 2001 to 2007. France was followed by the United States, China, Morocco (in 4th position, a decrease since 2001), Tunisia, Mexico, and Lebanon. Jordan was in 27th position in 2001 and 37th position in 2007. Overall, for all years, Jordan was in 31st position, dropping from 0.79% of students in 2001 to 0.43% in 2007, a percentage-point decrease of 0.35%.

Even with all the progress made and with all the existing programs, there is still a need for scientific role models, within and outside the MENA region. To fulfill this need, it would be important to establish a list of scientists and mathematicians working and living abroad and keep in touch with them by keeping them involved in scientific activities. It would be crucial also to acknowledge their expertise and, moreover, to promote and be proud of all outstanding researchers within the MENA region and from the diaspora. (Nobel Prizes, L'Oreal, etc.).

To the question "Was it easy to choose Science?" I respond that I do it because I had excellent grades in mathematics and in science. Because I am the eighth in a family of nine children, five of them boys, I had to be the best, to convince my family to let me pursue my studies in France. The first months were very tough: I had to not only succeed in my studies, but also adapt to a totally different environment while having the pressure of bringing the family honor. My mother was my role model, my source of motivation and inspiration. She supported me since my childhood and encouraged me to pursue studies, even while she was illiterate. "Women have to get an education to change things and minds," she always repeated to me.

3. Increasing the participation of women and girls in science

In 1997, the Natural Sciences and Engineering Research Council of Canada (NSERC), in collaboration with corporate sponsors, established five regional chairs for women in science and engineering (CWSE). These chairs have as their main goals (1) increasing the participation of women in science and engineering and (2) providing role models for women active in, and considering, careers in these fields within their respective regions.

Specifically, the chief objectives of those chairs are as follows (see www.nserc-crsng.gc.ca/Professors-Professeurs/CFS-PCP/CWSE-CFSG_eng.asp):

- To develop, implement, and communicate strategies to raise the level of participation of women in science and engineering, both as students and as professionals, Toward this end, the chairs seek to
 - encourage female students in elementary and secondary schools to consider careers in science and engineering,

- increase the enrolment of women in undergraduate (bachelor's degree) and graduate (master's and Ph.D. degrees) programs in science and engineering in all Canadian universities and colleges,
- increase the profile and retention rate of women in science and engineering positions,
- eliminate barriers for women who wish to pursue careers in science and engineering, and
- promote the integration of female students and professionals both within and outside academia.
- To provide female role models who are accomplished, successful, and recognized researchers in science and engineering.
- To develop and implement a communication and networking strategy to ensure a regional and national impact on opportunities for women in science and engineering.

4. Some specific projects to nurture talent in science and engineering

Many actions have been taken by the NSERC-industry chairs to promote science and engineering for girls and young women. Among others, the NSERC-Cameco Chair at the Prairies has undertaken the *Science Ambassadors project*, an initiative for aboriginal students. The aim of this project is to have graduate students in science and engineering assist science teachers in schools with a high proportion of aboriginal students, setting up hands-on activities and explaining science concepts in interesting and culture-related ways.

The NSERC-Hewlett Packard Chair for Ontario focuses on youth outreach with two free interactive workshops. The first workshop, *SET, go!*, introduces students from both elementary schools (grades 7–8) and high schools (grades 9–12) in Ontario to the vast range of career opportunities in science, engineering, and technology (ergo the acronym *SET*). The second workshop, *Codes, Computers, and Communicating with Aliens*, designed for the same age groups, introduces students to the functioning of computers and electronic devices and to the task of communicating information (numbers, text, and media). Both workshops are presented by female role models, but address male and female students.

In British Columbia and Yukon Territory, the NSERC-General Motors Chair directed *The Jade Project*, a global project aiming to support girls and women who are interested in the mathematical, computing, and physical sciences and engineering. One of the initiatives is *the Jade Treasures Project*, which supports the participation of female students from grades 1-12 in computer science, robotics, and engineering activities. The project also provides materials for high school students (grades 7–12) that dispel common myths about the field of computer science. In addition, *The Jade Treasures Project* helped initiate the *GirlSmarts Workshop*, a computer science workshop for girls in grade 6.

The NSERC-Petro Canada Chair in the Atlantic provinces supported outreach activities within the framework of the biannual conference of the Canadian Coalition of Women in Engineering, Science, Trades and Technology. The theme of the conference this year is *Networking: Building Your Career Alongside Your Graduate Studies, a Workshop by and for Graduate Students in Science and Engineering*. This workshop enables the participants to refine and enhance their networking skills for their various professional careers in science and engineering. The chair also collaborated with Women in Science and Engineering Newfoundland and Labrador (WISE NL) in order to offer that group ongoing logistical and financial support for its Summer Student Employment Program (SSEP), which provides practical work experience to female students in grade 11, helping them to start on their career path.

In Quebec, I hold the NSERC-Industrial Alliance Chair and have led initiatives to promote science and engineering for girls and young women. Two programs focus more on female students from grades 8 and 9, and grade 12. The first project, “Les filles et les

sciences, un duo électrisant!” (*Girls and sciences, an electrifying duo!*), is a one-day event for girls in grades 8 and 9 (the second and third years of high school in Quebec) that gives them a unique opportunity to discover exciting careers in science and technology through activities, discussions, and experimentation workshops. The workshops are held in the morning.

(Included this year were a perfume-making workshop and a workshop in mathematics, on the making of a Möbius strip.) The girls were invited to visit many booths on their lunch break, in the activity “Magasin ton avenir” (*Shop your future*). A creative science activity was held in the afternoon. The second project, “Future Ingénieure?” (*Future Woman Engineer?*), is a mentorship activity that aims to demystify the engineering profession for 12th-grade students (students at the level of collège d'enseignement général et professionnel¹—CEGEP—in Quebec) by giving them the opportunity to spend four hours to a day with an engineer or a group of engineers in the field of the students’ choice. The visits were held in winter, in January or February, just before the end of the main application period for universities in Quebec. In 2009, in Quebec City, 12 students were matched to six businesses and research centers: DESSAU, Research Group in Hydraulic Turbines of Laval University, Hydro-Quebec, Defence Research and Development Canada (DRDC), the Ministry of Transportation of Quebec and BPR-Bechtel.

The aim of those projects led by the five NSERC-industry chairs is to attract and retain girls’ interest in science, because the loss of this interest is too often the heart of the issue of the underrepresentation of women in science, technology, engineering, and mathematics (STEM). Retention of that interest is also the key to attracting talented women, by fostering their passion for science and encouraging them to maximize the opportunities afforded them by scientific careers.

5. Some specific projects in the popularization of mathematics

Another project, more focused on mathematics, is *Sciences and Mathematics in Action* (SMAC). The mandate of this global project, designed for students from grades 6 to 12, is to stimulate and reinforce the interest of youths in mathematics and science in general and to demystify mathematics for the general public. The project takes the form of two main initiatives: *Show Math* and *MathAmaze* (www.smac.ulaval.ca/en). *Show Math* is a multimedia show at the junction of mathematics, multimedia, and humor. Animated by professors from Laval University, the show provides an entertaining way to make mathematics accessible, with videos and comic sketches, enabling the participant to discover the role of mathematics in our daily life. A free pedagogical kit, *Show Math in the Classroom*, built with the financial support of the Ministry of Economic Development, Innovation and Export Trade of Quebec, is provided for teachers to prepare students to better understand the material presented during *Show Math*. The kit includes math activities to be done before or after the show. *Show Math* has been presented more than a hundred times since 2005, from the province of Quebec to Ontario, New-Brunswick, and British Columbia. Two editions of this show are currently available, in French and in English. The following are among the topics recently presented in *Show Math*:

- How one can find the winning combination of numbers for the next draw of the 6/49 lottery by examining the decimals of π ?
- Did you know that mathematics makes it possible for MP3 players to contain all that information?
- How can you use the playing of heads or tails to tell whether someone cheated?
- Did you know that in any gathering of 23 or more people, there is a 50% chance that at least two of them were born the same day of the year?
- Cryptography
- Global Positioning systems (GPS)
- Fractals

- What would the world be like without numbers?

The second project, *MathAmaze*, is an interactive multimedia game created by the SMAC team. The game is available free on the Web (www.mathenjeu.ca), in French and in English. It does not need any special installation. It aims to help youths discover mathematics through games and to reintroduce the general public to mathematics. *MathAmaze* is a board game in which the goal is to accumulate as many coins as possible, in a limited time, by answering mathematical questions. Up to four players can play together, one against the other, moving on a randomly created board. The more spaces in a move, the harder is the mathematical question, and the more points it is worth! If the answer of the player is incorrect, the reason for the mistake is shown and explained and the right answer, and the process used to obtain it, is detailed. The player can move independently and simultaneously. The question bank of *MathAmaze* includes 1,500 questions in eight different categories (geometry, logic, algebra, arithmetic, probability and statistics, history of science, functions, and general questions). The number of points earned for each correct answer corresponds to the level of difficulty of the question, taking into account the academic level of the player. Therefore, as the questions are adapted to the academic level of a player, two players with different academic levels can play against each other in the same game. *MathAmaze* can also be used to do homework from home; a teacher may ask permission from the SMAC team, to isolate a question category (e.g., geometry) or to add his or her own questions to the game. In the months that follow, new questions for elementary and middle school levels will be added to the game. In addition, because the software is modular, it will eventually be used to build similar games in other sciences.

The two initiatives led by the SMAC Team, *Show Math* and *MathAmaze*, aim to capture students' interest in mathematics by having the students observe the presence of mathematics in their own daily lives and exploring it through games, which can lead them, afterwards, to an interest in pursuing studies in the field. The two games nurture the passion of talented students.

6. Some research papers on women in science and engineering

A statistical study led by Boiteau and Ghazzali (2008), "Profils des inscriptions des étudiants aux trois cycles universitaires au Québec de 1999 à 2007" (*Students' registration profiles at undergraduate and graduate levels in Quebec from 1999 to 2007*), aims to analyze the situation of all students, by gender, who have earned bachelor's, master's, and Ph.D. degrees, for all universities in Quebec. This study is extended by Ghazzali and Morin-Rivest (2010) in order to analyze the behavior of international students coming from 194 different countries and studying in the universities of Quebec. Their paper is titled "Profil des inscriptions des étudiants étrangers aux trois cycles universitaires au Québec de 2001 à 2007" (*International students' profiles at undergraduate and graduate levels in Quebec from 2001 to 2007*).

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¹ General teaching and professional college