Building scientific and technological talent in the
Broader Middle East and North Africa region (BMENA)
Arab capability status, present development, and proposed action plan
Dr. Wagdy Sawahel
General coordinator, Islamic Development Bank (IDB) science development network
Coordinator, Organization of Islamic Conference's (OIC) Standing Committee on Scientific
and Technological Cooperation (COMSTECH)
Virtual Incubator for Science-based Business (VISB)
General coordinator, science development program, Royal Academy of Science
International Trust, USA
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Executive Summary
Science and technology, in general, can be considered an important factor in solving the problems of socioeconomic development and producing a high quality of life in which man has been transformed from a social burden to a productive contributor. Rapid technological development has fundamentally altered economic development principles and is just as rapidly changing the way value is created, transforming the nature of dynamic competitiveness.

Arab countries are entering a new phase of economic development, with an emphasis on the crucial role of science and technology in promoting sustainable development. To translate that idea into action, Arab leaders have agreed to make education and scientific research a permanent item at all future Arab summits, calling on the Arab states to put science at the heart of their strategic plans. Arab leaders also have adopted a number of decisions aimed at building technological capacity, supporting science education, and promoting private-sector investment in science and technology. Finally, Arab leaders are seeking to create opportunities for collaboration between scientific and technological institutions in various countries. In order for the Arab countries to overcome their current status as a group of developing countries and attain a higher status, they must make use of their abundant resources, especially that most abundant resource: human capital. Thus, the next step is to transform these decisions into action.

This report presents the current status of Arab science and technology capabilities and the international and regional rankings of Arab higher education institutions. The report also analyzes the main science-and-technology-related decisions arrived at during Arab summits, as well as the chief strategic objectives and areas of focus of those meetings, including improving science education and upgrading universities; increasing scientific research capabilities; harnessing science, technology, and innovation for economic development and social benefits; increasing financial support for research and development (R&D); and enhancing regional and international scientific cooperation. In addition, selected programs were proposed for the experts who were meeting to kick-start a realistic and applicable action plan that addresses the challenges of science-based development from an integrated perspective that promotes new ideas and builds on consensus.

The suggested plan is divided into two stages: (1) a networking-based short-term plan that includes the setting up of a network of science and technology excellence centers, an Arab universities network for science education, and an Arab intelligence system for promoting investment in science and (2) a long-term plan based on a needs assessment for each of the countries involved. The first stage will also include the preparation of a road map for all science, technology, and higher education strategies in the Arab world and a directory of all funds that have been established in the Arab world such as an Arab gulf fund for climate change and an Islamic fund for agricultural research and food. The road map will also report on available opportunities for enhancing regional and international scientific cooperation for technology transfer. The results of the first stage will be used to set forth the second-stage need-based long-term plan.

I. General introduction

The scientific progress achieved at the end of the twentieth century has spawned an economic revolution, like the industrial revolution, that is transforming our everyday life and producing radical changes in the global economic landscape. For example, information technology is effectively eliminating national borders around the world, and emerging fields in biotechnology and nanotechnology will lead to an unprecedented understanding and advancement of the industrial and service sector through the introduction of new products and processes.

As knowledge becomes more important, so does higher education. In today's world economy, workers not only need a college degree in a specific subject, but also need to be resourceful, skillful, and able to quickly identify and solve problems. These strengths can be cultivated only in quality universities at the center of first-class higher education systems.

Advances in technology are changing the way people work and live, and industrialization depends increasingly on planning, technology, and management—skills attainable only by a highly educated work force. Innovation is considered to be the most important driver of growth in a knowledge-based economy, through its direct impact on technological progress and higher productivity. In developing countries, it is regarded as a major pillar of economic development. However, innovation is the outcome of the quality of the higher education system in a given economy.

Although, historically, Arab culture has contributed a great deal to the world's scientific development, today the region lags behind in many critical science and technology indicators. Although some Arab countries have huge resources and cash reserves, the dismal state of higher education in the Arab World is evident from the fact that, among the 22 member countries of the Arab League, only two Arab universities in Saudi Arabia rank within the top 500 universities in the world. No Arab country is classified as economically advanced or scientifically proficient, while six Arab states are designated as among the least developed countries.

In this increasingly globalized world, knowledge is fast replacing physical resources, cheap labor, and cash reserves as the driver of growth. Accordingly, Arab states need to formulate and implement a reasonable and realistic action plan for the modernization of the higher education sector and for the development of the required research capacity, with the aim of establishing sustainable knowledge and science-based economic development.

II. Present status of Arab science and technology capacity

The Arab region is composed of 22 countries, which cover some 10 percent of the world's land area and are home to about 300 million, representing 4.5 percent of the world's population. The wealthiest Arab countries, those with the most natural resources, particularly oil, include the 6 Arab countries in the Arab Gulf Cooperation Council. The poorest Arab countries include 6 of the world's 50 least developed countries: Comoros, Djibouti, Mauritania, Somalia, Sudan, and Yemen. The remaining Arab states are classified as middle-income countries.

On average, Arab countries spend less than 0.2 percent of their gross domestic product (GDP) on research and development, compared with 1.6 percent in East Asia and the Pacific and 2.6 percent in member countries of the Organization for Economic Cooperation and Development (OECD). Just 6.2 percent of the region's budget is allocated to fundamental research. The amount of money spent each year on Arab military needs imported from abroad is more than the combined investment in health, education, and research and development.

Private enterprise in the Arab region accounts for just 1 percent of research and development, universities 30 percent, and government 69 percent. By contrast, among OECD countries, 70 percent of all research and development is performed by private enterprise, 17 percent by universities, and 10 percent by government.

The 2007 *Trends in International Mathematics and Science Study* published in December 2008 shows Islamic states lagging behind industrialized countries in the teaching of math and science to young students. As a result, the number of scientists and engineers working in Arab countries is 124 per million population, compared with 2,830 per million population in OECD countries. The 124-per-million figure surpasses only the African region and is lower than the 313-per-million average for all developing countries. About 44 percent

of Arab researchers work in the water and agriculture sectors, indicating that the region has not yet entered into the intellect-intensive knowledge economy.

As a result of this very small number of scientists, the Arab world contributes only minimally to the world's scientific research output, as measured by publications in peer-reviewed international journals and the awarding of international patents for technological innovation. The number of scientific publications originating in the Arab region accounts for only 1.1 percent of the world total.

There are fewer than 25 computers per 1,000 people in the Arab region, compared with the global average of 78.3. Similarly, in 2000, 1.6 percent of the Arab population was using the Internet, as opposed to 30 percent in the United States. However, some Arab countries, such as the United Arab Emirates and Bahrain, have a significant number of Internet users: 30 percent and 19 percent, respectively.

Despite the aforementioned discouraging figures, Arab states have demonstrated the most improvement in technology readiness of any region in the world, according to a new report. The seventh annual *Global Information Technology Report,* (GITR) published by the World Economic Forum (WEF) and French management school INSEAD, the leading business school in Europe, was released in 2008.

The report assesses 127 nations on factors ranging from the cost of mobile phone calls and available Internet bandwidth to the quality of higher education, in order to identify which countries are best positioned to compete in the information-intensive twenty-first-century economy. The report shows that Arab states have risen significantly in the rankings. Egypt, at position 63 in the study, climbed 17 places from its position in the 2006–2007 report—the biggest jump in the sample. Bahrain, Jordan, and Qatar leapt 6, 4, and 11 places, respectively. Oman and Saudi Arabia, new to the report, entered at positions 53 and 48, respectively.

The report presents Qatar as a flag bearer of technology-driven excellence in the region. In just four years, Qatar has risen to position 32 in the rankings by establishing the Supreme Council of Information Communication Technology, which has implemented an information communication technology (ICT) national plan, as well as initiatives in health care, education, and infrastructure. Also, according to a February 2010 report entitled *Geopolitical Shifts in Knowledge Creation*, published by Canada-based Science-Metrix, the Middle East is currently growing in science at a rate higher than that of overall world science.

III. Arab higher education institutions: International and regional view

Currently, there are about 200 universities in the Arab world, employing 140,000 faculty members to teach 3.6 million students. However, the region's growing population means that enrollment is expected to rise to 5.6 million by 2015, requiring an extra 110,000 faculty.

1. International ranking

   A. Shanghai's *Academic Ranking of World Universities*

The much-publicized *Academic Ranking of World Universities*, compiled by Shanghai's Jiao Tong University, was a large-scale Chinese project to provide independent rankings of universities around the world, primarily to measure the gap between most Chinese universities and world-class universities.

The Shanghai ranking uses a weighted composite sum. Shanghai appraises education and faculty on the basis of Nobel Prizes and Fields Medals that they were awarded and whether they are highly cited researchers. Shanghai measures research by counting nonreview articles in *Nature* and *Science*, as well as the total number of published articles. Also, a weighted average of these indicators is adjusted for institutional size and contributes 10 percent to the final sum.

One of the primary criticisms of the ranking is its bias toward the natural sciences over other subjects and toward science journals in the "Anglosphere." This bias is evidenced by the inclusion of criteria such as the volume of articles published in *Science* or *Nature* (both journals devoted to the natural sciences are published in English) and the number of Nobel Prize winners (the prizes are awarded predominantly in the physical sciences) and Fields Medalists (awarded in mathematics).

In 2010, King Saud University and King Fahd University of Petroleum and Minerals were the sole Arab universities ranked within the top 500 international universities in the Shanghai ranking.

B. The *Times Higher Education* supplement (THES)– Quacquarelli Symonds "World University Rankings"

THES, a British publication, in association with Quacquarelli Symonds (QS), publishes the annual THES–QS "World University Rankings," a list of 400 ranked universities from around the world. The Times ranking is a composite system. The ranking assigns much weight (40 percent of the total) to an expert opinion survey. Additional components address the rating from graduate recruiters, the recruitment of international faculty, the enrollment of international students, the student-to-faculty ratio, and total number of citations.

QS rankings face criticism due to the more subjective nature of their assessment criteria, which are based largely on a peer review system of 1,000 academics in various fields. The 2009 QS "World University Rankings" mention no universities from Arab states and only one university—the University of Malaysia—from Islamic world.

C. Scientific Research Performance Ranking

The Scientific Research Performance Ranking is different from both the THES–QS "World University Ranking," which focuses on universities, and the Shanghai Jiao Tong University ranking, which focuses on academics. The Scientific Research Performance Ranking evaluates and ranks the scientific papers published by faculty in the top 500 universities worldwide. The ranking is composed of nine indicators that together assess a university's overall scientific paper "performance" along three criteria: research productivity (accounting for 20 percent of the total ranking), research impact (30 percent), and research excellence (50 percent). The emphasis on current research makes the indicators a fairer measure than some traditional indicators, such as a university's reputation and the number of Nobel Prize winners affiliated with that university. These indicators tend to favor universities with longer histories or universities in developed countries.

Although many institutions from developing countries such as Mexico, Brazil, India, South Africa, and Argentina were included in the top 500 universities of the 2007 Scientific Research Performance Ranking, not a single university from the Arab or even the Islamic world was mentioned.

2. Regional ranking

   A. Statistical, Economic and Social Research and Training Center for Islamic Countries (SESRTCIC) ranking

A 2007 report on the academic rankings of universities participating in the Organization of the Islamic Conference (OIC), prepared by the Turkish-based SESRTCIC, an OIC affiliate, showed the top 20 universities according to a composite index (research quality, research performance, research volume, and rate of growth of research quality):

Top 20 universities by the composite index

Rank	University	E-mail address	Country
1	Koç University	http://www.ku.edu.tr/main.php	Turkey
2	Quaid-i-Azam University	http://www.qau.edu.pk/	Pakistan
3	Razi University	http://www.razi.ac.ir/	Iran
4	Tarbiat Modares University	http://www.modares.ac.ir/	Iran
5	University of Tabriz	http://www.tabrizu.ac.ir/	Iran
6	Hacettepe University	http://www.hacettepe.edu.tr/english/	Turkey
7	Suez Canal University	http://scuegypt.edu.eg/	Egypt
8	Universiti Kebangsaan Malaysia (National University of Malaysia)	http://www.ukm.my/ukmportal/	Malaysia
9	United Arab Emirates University	http://www.uaeu.ac.ae	United Arab Emirates
10	Kuwait University	http://www.kuniv.edu.kw/	Kuwait
11	Istanbul University	http://www.istanbul.edu.tr/english/	Turkey
12	American University of Beirut	http://www.aub.edu.lb/	Lebanon
13	University of Malaya	http://www.um.edu.my	Malaysia
14	Inönü University	http://www.inonu.edu.tr/univeng/	Turkey
15	Amirkabir Univ. of Technology	http://www.aut.ac.ir/	Iran
16	Çukurova University	http://www.cu.edu.tr/Content/Asp/English/index.asp	Turkey
17	Bu-Ali Sina University	http://www.basu.ac.ir/	Iran
18	Shiraz University	http://www.shirazu.ac.ir/index.php	Iran
19	University of Tehran	http://www.ut.ac.ir/en/index.htm	Iran
20	Cairo University	http://www.cu.edu.eg/english/	Egypt

B. OIC Standing Committee on Scientific and Technological Cooperation (COMSTECH) ranking

COMSTECH has produced a ranking of the top 25 productive universities in the Muslim world:

University and e-mail address	Country	Publications*
1. Hacettepe University http://www.hacettepe.edu.tr/english/	Turkey	8,979
2. Istanbul University http://www.istanbul.edu.tr/english/	Turkey	6,488
3. Ankara University http://www.ankara.edu.tr/english/	Turkey	5,982
4. Cairo University http://www.cu.edu.eg/english/	Egypt	4,977
5. Kuwait University http://www.kuniv.edu.kw/	Kuwait	4,495
6. King Saud University http://www.ksu.edu.sa/sites/ksuarabic/Pages/Home.aspx	Saudi Arabia	4,336

7.	Middle East Technical University http://www.metu.edu.tr/	Turkey	4,215
8.	Gazi University http://www.gazi.edu.tr/english/indexeng.php	Turkey	3,652
9.	Istanbul Technical University http://www.metu.edu.tr/	Turkey	3,452
10.	Ege University http://www.ege.edu.tr/	Turkey	3,336
11.	King Fahd University of Petroleum and Minerals http://www.kfupm.edu.sa/	Saudi Arabia	3,323
12.	Ain Shams University http://net.shams.edu.eg/History.asp	Egypt	3,129
13.	University of Malaya http://www.um.edu.my/	Malaysia	2,862
14.	National Research Center http://www.nrc.sci.eg/Default.asp	Egypt	2,651
15.	Alexandria University http://www.alex.edu.eg/	Egypt	2,628
16.	American University of Beirut http://www.aub.edu.lb/	Lebanon	2,568
17.	Atatürk University http://www.atauni.edu.tr/	Turkey	2,535
18.	United Arab Emirates University http://www.uaeu.ac.ae/	United Arab Emirates	2,478
19.	Mansoura University http://www.mans.eun.eg/	Egypt	2,439
20.	King Faisal Research Center http://bportal.kfshrc.edu.sa/wps/portal/RC	Saudi Arabia	2,434
21.	Universiti Sains Malaysia http://www.usm.my/en/	Malaysia	2,402
22.	Dokuz Eylül University http://www.deu.edu.tr/DEUWeb/English/	Turkey	2,389
23.	Uzbek Academy of Sciences http://eng.uzsci.net/academy/	Uzbekistan	2,169
24.	Çukurova University http://www.cu.edu.tr/Content/Asp/English/index.asp	Turkey	2,026
25.	University of Tehran http://www.ut.ac.ir/en/index.htm	Iran	1,962

* Ten-year Publication Rate (1995–2005)

3. Leading BMENA countries in science and technology and in higher education

Egypt and Saudi Arabia are leading the Arab scientific and higher education revolution. For example, with the implementation of the reform plans of the Saudi Ministry of Higher Education, (MOHE) which has launched several higher education initiatives in technical readiness and infrastructures, Saudi Arabia is starting to take a prominent place in the scientific and technical domains, both regionally and internationally. These reform plans are being carried out through transforming Saudi universities into "functional developmental institutes" via a careful balance of international academic standards, national needs, local cultural identity, and careful management of the production, management, dissemination, access, and control of knowledge. Following are some remarkable achievements by Saudi

Arabia that have been documented in international reports:

- Recent international university rankings show that Saudi Arabia–based universities have taken a place among the world's top universities. According to the June 2010 Webometrics Ranking of World Universities, 3 Saudi Arabian universities were among top 200 world universities and 6 Saudi Arabian universities were included in the top 10 universities in the Arab Gulf States, Arab world, and Islamic states. Also, Saudi Arabia was ranked 31st globally with regard to the efficiency of its higher education system.
- In its 2010 survey, INSEAD ranked Saudi Arabia 54th in its international assessment of the impact of innovation on competitiveness and growth in the world, 17th in the Asian region, and 5th in the Middle East and North Africa (MENA) region, citing its high marks in investment in education, technology transfer, and knowledge applications.
- According to the ninth annual GITR 2010 report released on 25 March 2010, Saudi Arabia ranked 38th globally and 4th in the Arab world in its readiness to "compete in the information-intensive twenty-first century economy." The country was ranked first and second, respectively, with regard to university–industry collaboration in R&D and the quality of scientific research institutions.
- Saudi Arabia is gaining a strong international position in innovation capacity as a result of its ambitious efforts at higher education reform, according to international indicators and reports such as the Global Competitiveness Index (GCI), World Intellectual Property (IP) indicators, and Google studies.
- GCI positioned Saudi Arabia 45 places ahead of India and Brazil in the number of utility patents granted in 2008 per million population. At Google Day Arabia 2.0, held February 2010, it was announced that 3,224 patents were filed from the Middle East and North Africa region in the last 13 years, with Jordan, Saudi Arabia, and Morocco at the top. The World Intellectual Property Organization's (WIPO) 2009 World IP Indicators revealed that the 2008 Patent Cooperation Treaty (PCT) filing in Saudi Arabia was 60 (which was considered "very high" for non-resident filings) with an average annual growth rate of 16.5 in the period 2003–2008.
- In its annual GCI Report, the 2009 World Economic Forum recognized Saudi Arabia as being among the top 30 most competitive economies, putting it in 28th position out of 133 countries studied.
- Saudi Arabia has surpassed advanced economies such as Portugal, Spain, France, and Russia, as well as knowledge-intensive economies such as India and Brazil, in innovation capacity. (World Economic Forum Report 2009).
- On the basis of scientific and technological productivity, as measured by the publication of research in established journals, Saudi Arabia was ranked number 4 among the top 10 most scientifically productive countries in the Muslim world. (COMSTECH Ranking; OIC standing committee on scientific and technological cooperation).
- A recent study, *A New Golden Age,* published in June 2010 by the Royal Society of London puts Saudi Arabia at the top of Gulf countries and second in the Arab world in scientific productivity.
- According to a world investment report the United Nations Conference on Trade and Development (UNCTAD) innovation capacity index has Saudi Arabia 55th out of 117 countries, ahead of Turkey, Malaysia, Brazil, and China. The report also put Saudi Arabia 3rd in the Arab world and 4th in the Islamic world.
- Although women constitute only slightly more than one-quarter of the world's researchers, women are 17 percent of Saudi researchers, a percentage higher than that

in Germany (12 percent), Japan (12 percent), and Korea (11 percent) and the same as that in Luxembourg, according to a recent United Nations Educational, Scientific and Cultural Organization (UNESCO) report entitled *Women in science: Under-represented and Under-measured*. Also, Saudi women outnumber western women in worldwide university enrollments and graduation rates, according to the 2009 *Global Education Digest* of UNESCO.

Iran and Turkey are leading the scientific and higher education revolution in the Middle East region. According to the February 2010 report *Geopolitical Shifts in Knowledge Creation*, published by Canada-based Science-Metrix, a company that specializes in the evaluation of science, technology, and innovation for economic development, Iran is showing the fastest worldwide growth in science, its scientific output having grown 11 times faster than the world average from 1980 to 2010. Despite more than 30 years of sanctions, Iran has made significant progress in various sectors, including aerospace, nuclear and medical sciences, agriculture development, and stem cell and cloning research.

IV. Main decisions of Arab summits related to science and technology

As a result of increasing recognition that the economic development challenges confronting the Arab states can no longer be ignored and that science, technology, innovation, and higher education can no longer be dismissed as inessential factors better left to wealthier regions of the world to pursue, at their annual Arab summit Arab leaders adopted a number of decisions aimed at establishing a science-based economy and promoting knowledge in Arab society.

1. Arab summit 2006 in Khartoum, Sudan

Arab leaders have agreed to collaborate more closely on research and increase their funding of science and technology. The commitment was outlined in a declaration made on 29 March at a summit of the 22 member nations of the Arab League in Khartoum, Sudan. The Khartoum declaration also calls on Arab nations to increase their research capacity, enact policies to promote quality in science, and encourage public–private research partnerships.

The proposals to boost science in the Arab world were put forward by Sudan, whose president, Omar Hassan al-Bashir, opened the summit with a call for members of the Arab League to put science at the heart of their strategic plans. Al-Bashir said it was sad that a single U.S. university could spend more on research than all Arab countries put together. He suggested that the increasing revenues from oil production should be used to fund science and technology development.

Collectively, Arab nations spend 0.15 percent of their gross domestic product on research and development, well below the global average of 1.4 percent.

The Arab League's secretary general, Amru Musa, called for reform of the educational systems in Arab countries and for the creation of an education and scientific organization.

2. Arab summit 2007 in Riyadh, Saudi Arabia

In a bid to narrow the science and technology divide between Arab States and industrialized nations, Arab leaders approved a 10-year plan for scientific research and development. The plan was signed off at a two-day summit of the 22 member nations of the Arab League in Riyadh, Saudi Arabia, held March 28–29. The plan calls on Arab countries to spend 2.5 percent of their GDP on R&D over the next 10 years.

Arab States have also agreed that they should spend at least 7 percent of their GDP on education, including science and technology teaching programs. They plan to increase the peaceful use of nuclear energy by establishing national authorities to monitor its use more transparently.

In past years, several Arab States expressed an interest in making more use of nuclear power. Their declaration cited "the right of all countries to possess peaceful nuclear energy according to international terms of reference, and their emerging inspection and control regime." They will build nuclear reactors for scientific research and expand the role of nuclear science in educational, economic, and medical activities. Arab leaders agreed to make education and scientific research a permanent item for discussion at all future Arab summits.

At the 27 March meeting of Arab foreign ministers in preparation for the summit, Sudanese Foreign Minister Lam Akol announced the Sudanese government's donation of land in Khartoum for the establishment of the Arab Federation of Scientific Research. The Federation would coordinate and support science organizations, with the aim of establishing a knowledge-based Arab society. The Federation also would promote a science-based economy, as well as specialized scientific centers for future technologies, such as biotechnology, nanotechnology , information technology, and renewable energy.

3. Arab summit 2008 in Damascus, Syria

At a summit of the 22 member nations of the Arab League in Damascus, Syria, held March 29–30, Arab leaders presented and approved a 10-year strategy (2008–2018) for higher education. Built on an earlier plan signed in 2007, the strategy calls for an increase in the ratio of students enrolled in science and technology at the undergraduate level, from 30 to 45 percent, and encourages more women to pursue scientific careers.

The strategy also seeks to increase the number of Arab postgraduate research centers. Eighty percent of Arab postgraduate students currently study abroad, a factor that is contributing to an Arab "brain drain." To implement the strategy via grants and loans, the plan encourages the establishment of a special fund, to be located at the Tunisia-based Arab League Educational, Cultural and Scientific Organization (ALECSO).

An action plan will be prepared to ensure that the strategy is implemented. Implementation of the plan will be monitored and evaluated by means of specific indicators, such as the number of patent applications filed, the number of research papers published, the number of women researchers recruited, and measured productivity growth.

The strategy also recommends setting up special higher education programs to provide the private sector with a skilled scientific work force. The league says that these programs will help encourage the private sector in Arab countries to increase funding for higher education and research; currently, such funding stands at only 1 percent of total financial support for higher education and research. The strategy also calls for promoting all ways of learning, including distance learning and open learning.

The plan calls for reforming science and technology teaching at all levels of Arab educational systems, with more focus on basic sciences and mathematics, as well as on modern fields in which the Arab world lacks expertise, such as biotechnology, information technology, nanotechnology, and renewable energy.

The plan also calls for establishing both regional and national centers of excellence in fields necessary for security and socioeconomic development, such as water and desert sciences, food, environment, information technology, agriculture and fishing, and renewable energy, as well as poverty and diseases. Member states of the Arab League will fund the strategy. A report addressing its implementation and progress was presented at the 2009 Arab summit in Doha, Qatar. To assess the progress in implementing the higher education reform strategy, an "Arab education observatory" will be established.

In addition to approving the higher education strategy, the Arab summit adopted a proposal from Algeria to launch a scientific satellite to monitor the earth and adopted the five-year Arab communication and information strategy (2007–2012) in a bid to bridge the digital divide and boost access to information.

The Arab scientific satellite will be used for observation and data collection pertaining to the earth, as well as serving the environmental field in general, by, for example, monitoring deforestation. The five-year Arab communication and information strategy is designed to turn the Arab economic system into one that is more representative of a new era of knowledge and technology.

4. First Arab economic and social development summit 2009, Kuwait

Arab leaders have approved the Science and Technology Plan of Action (STPA) in a bid to develop a knowledge-based economy, according to a Kuwaiti declaration. STPA was approved by the 22 member nations of the Arab League at the first Arab economic and social development summit held in Kuwait, 19-20 January 2010. Higher education experts and science and technology specialists from Egypt, Saudi Arabia, and Tunisia, among other countries, prepared STPA in cooperation with the Tunisia-based ALECSO and the UNESCO.

STPA proposes a mechanism for the implementation of the various regional science and technology and innovation policies and strategies adopted by the Arab League summits in a bid to build the golden triangle of science advancement, namely, higher education, research and development, and innovation. Under the plan, an Arab League Council of Ministers of Science and technology similar to the one on higher education will be established and a stable funding mechanism will be set up.

The initial stage of STPA includes setting up a network of science and technology excellence centers in the Arab world for promoting interactive approaches to encourage excellence in innovation. The network will use selected outstanding scientific and technological institutions in the Arab states as regional hubs for facilitating cooperation through joint research projects as well as for promoting learning and training through the organization of training programs. STPA identifies water, food, agriculture, and energy as priority areas.

Besides promoting links within the Arab scientific community and strengthening the mobility of scientists within Arab states, the STPA includes a program for promoting collaborative research and innovation activities with Arab scientists living abroad.

In a bid to monitor and analyze scientific and technological developments and their relation to, and interaction with, Arab society, an Arab science and technology observatory will also be established. To make sure that the plan is implemented, a progress report will be prepared by ALECSO and presented at the second Arab economic and social development summit, due to be held in Cairo, Egypt, in 2011.

V. Main strategic objectives and areas of focus

Arab leaders agreed to make education and scientific research a permanent item at all future Arab summits and called on the Arab states to put science at the heart of their strategic plans. The main strategic objectives and areas of focus are based on the Arab summit decisions.

 1. Improving science education and upgrading universities

Because it produces large numbers of university graduates with a set of scientific skills that is inadequate for today's market, the education system is one of the important factors hindering science development in the Arab world. Arab countries produce an excess of graduates in conventional fields; therefore, efforts should be focused on emerging sectors such as technology. The dismal state of higher education in the Arab world is evident from the fact that only one Arab university (Cairo University, Egypt) is currently ranked among the world's best 500 universities. (Cairo University is ranked third among African universities.)

Thus, one of the challenges facing the Arab countries today is the modernization of science education. There is a need for sweeping structural reforms, not the "cosmetic" brand

that "the decision-makers are carrying out most of the time." (UNESCO regional director Victor Billeh during a lecture at the American University of Beirut in May 2004).

This is because achieving excellence in higher education is closely linked to productivity in scientific research and to the development of sustainable knowledge-based economies in Arab countries.

Arab countries need to establish clearly defined educational policies, entice the private sector into setting up vocational training and certification programs, and teach "employability skills," such as computer science, communication, and foreign languages. There is also a need for small-business-oriented "enterprise training" and vocational guidance centers. Finally, Arab students must be exposed to the culture of research throughout their education, at the primary, secondary, tertiary, and graduate levels.

Although studies indicate that Arabs have more PCs per person than any other developing region except Latin America, they have even less access to the Internet than people in sub-Saharan Africa. In addition, although the Arabic language is one of the top six languages used in the United Nations and the Arab people constitute about 5 percent of the world's population, the number of Arab Internet users was estimated at 5 million, and the number of Arabic sites a mere 1 percent of the World Wide Web. As a result, Arab states require a substantial investment to modernize their higher education and research capacity. This requirement was reflected in the following Arab summit decisions:

- A call for Arab states to spend at least 7 percent of their GDP on education, including science and technology teaching programs.
- A call for an increase in the ratio of students enrolled in science and technology at the undergraduate level from 30 to 45 percent and for the encouragement of more women to pursue scientific careers.
- A call for setting up special higher education programs to provide the private sector with a skilled scientific work force. The Arab League says that these programs will encourage the private sector in Arab countries to increase funding for higher education and research; currently, such funding stands at only 1 percent of total financial support for higher education and research.
- A call for promoting all ways of learning, including distance learning and open learning.
- A call for reforming science and technology teaching at all levels of Arab educational systems, with more focus on basic sciences and mathematics, as well as on modern fields in which the Arab world lacks expertise, such as biotechnology, information technology, nanotechnology, and renewable energy.
- A call for assessing the progress in implementing the higher education reform strategy, in pursuit of which an "Arab education observatory" will be established.

 2. Increasing scientific research capacity

Although there are about 1,000 institutions of research and development, 200 universities, hundreds of colleges and scientific and technical institutes, 50,000 science and technology faculty members, 700,000 engineers, and 4 million science and technology graduates in the Arab world today, there is still a disconcerting discrepancy between the Arab countries and the technologically and scientifically advanced nations. To address this shortcoming, Arab countries have been called on to do the following:

  A. Enact policies to promote quality in science.
  B. Build science and technology capacity.

Toward realizing these ends, the following measures have been proposed:

- *Creation of an education and scientific organization.* The establishment of an Arab scientific research center will serve as the hub coordinating scientific research in the region. The center will support the development of technical and technological joint

Arab research projects and promote educational programs as well as encourage innovation.

- *Establishment of regional and national centers of excellence in fields necessary for security and socioeconomic development.* Among these fields are water and desert sciences, food, environment, information technology, agriculture and fishing, and renewable energy, as well as poverty and diseases.
- *Increase in the number of Arab postgraduate research centers.* Eighty percent of Arab postgraduate students currently carry out their study abroad, contributing to an Arab "brain drain."

The emigration of scientists, who are disenchanted by factors ranging from a lack of investment in research to social and political instability in the region, is threatening the future technological and scientific development of the Arab world, according to a 2004 study by Cairo's Gulf Center for Strategic Studies. The study found that the emigration of intellectuals from the Arab world accounts for about one-third of the total brain drain from developing countries to the West. Arab countries lose half of their newly qualified medical doctors, 23 percent of engineers, and 15 percent of scientists each year, with three-quarters of the emigrants moving to the United Kingdom, the United States, and Canada. This flight is estimated to equate to annual losses to Arab states of more than US$2 billion.

The study also found that 45 percent of Arab students who study abroad do not go back to their countries after graduating. As a result, Western states are the greatest beneficiaries of 450,000 Arabs with higher scientific qualifications. The study says that a range of political, economic, social, and personal factors are to blame for the brain-drain. These include the slow development in Arab countries, a failure to make adequate use of new technologies in the productive sector, low salaries, and the relative lack of opportunities to do scientific research.

Broader factors include the political and social instability in many countries in the region. Iraq, for example, is currently suffering a new brain drain as intellectuals flood out of the country to avoid unemployment and assassination attempts.

The following further measures have been proposed in pursuit of increasing Arab scientific research capacity:

- *Increase in the peaceful use of nuclear energy.* This measure establishes national authorities to monitor the use of nuclear energy more transparently.
- Construction of nuclear reactors for scientific research and expansion of the role of nuclear science in educational, economic, and medical activities.

At the 27 March meeting of the Arab foreign ministers in preparation for the summit, Sudanese Foreign Minister Lam Akol announced the Sudanese government's donation of land in Khartoum for the establishment of the Arab Federation of Scientific Research to coordinate and support science organizations, with the aim of establishing a knowledge-based Arab society and promoting a science-based economy and specialized scientific centers for future technologies, such as biotechnology, nanotechnology , information technology, and renewable energy.

3. Harnessing science, technology, and innovation for economic development and social benefits

Arab R&D still focuses on specific sectors such as agriculture, the environment, and health care, in contrast to high-technology fields such as biotechnology. Also, the private sector has preferred to import proven technologies than to develop them locally—even in sectors such as the petrochemical industry and water desalinization, in both of which the Arab world has expertise. Thus, the Arab League called for promoting public–private research partnerships with an eye toward facilitating the integration of scientific research, technological development, and innovation into the economy of the Arab world. The

partnerships would focus on promoting entrepreneurship, incubation, business accelerators, and training through R&D projects producing commercial applications in areas such as life sciences; sustainable industrial development; information and communication technologies; and sustainable management of the environment, energy, and water as the partnerships would also organize interactive forums, training programs, and science and technology events.

4. Increasing financial support for research and development

The Arab League has called on Arab countries to spend 2.5 percent of their gross domestic product (GDP) on research and development over the next 10 years. To implement this strategy via grants and loans, the plan encourages the establishment of a special fund, to be located at the Tunisia-based ALECSO. The League also suggested that the increasing revenues from oil production should be used to fund science and technology development.

5. Enhancing regional and international scientific cooperation

This cooperation must focus on European countries, China, Japan, and African and Islamic countries.

VI. A proposed action plan

Roundtables should be organized to bring together leaders in the scientific, development, and policy communities for the purposes of developing a realistic and applicable action plan that addresses the challenges of science-based development from an integrated perspective that promotes new ideas and builds on consensus. The action plan should be divided into two stages: a networking-based short-term plan and a need-analysis-based long-term plan.

1. Networking-based short-term plan

This plan will be based on using the scientific workforce and the technological and educational capacity that the Arab world already has on the ground or is in the process of establishing to implement the science and technology decisions made by the Arab league summits. The plan can be carried out by adopting the following measures:

A. Network of science and technology excellence centers

Building scientific capacity in the Arab world is a critical element in the region's overall efforts to promote sustainable development. To advance this goal, Arab countries must identify leading research institutions in the region that focus on science, technology, and innovation, with a special focus on scientific fields mentioned in the Arab summit decisions. In this regard, the Third World Network of Science Organizations (TWNOS) and the Academy of Science for the Developing World (TWAS) have published detailed profiles on institutions of excellence throughout the developing countries.

A review of projects in progress must be carried out. Among these projects is a center for groundwater research in Libya that UNESCO has agreed to establish in order to encourage networking and the transfer of knowledge between scientists from Africa and the Middle East. The center will promote scientific research, education, and sustainable development in the region. In particular, it will help develop policies to promote and coordinate cooperative research on technology to access shared groundwater.

In another project, Saudi Arabia will launch several new centers to boost nanotechnology research in the region. On February 26, King Abdul Aziz City for Science and technology, the Saudi Arabian national research and development organization, announced an agreement with the international research organization IBM Research to establish the Nanotechnology Center of Excellence in the capital, Riyadh. The two organizations will collaborate to identify and develop promising opportunities in nanotechnology. The center will research materials for solar energy and nanomembranes for the desalination of seawater. Researchers will also investigate new methods for recycling plastic materials.

Finally, King Abdullah of Saudi Arabia has donated US$9.6 million to establish further institutes at universities around the country to promote education and research in nanotechnology. The US$3.2 million King Abdullah Institute for Nanotechnology opened in 2008 at the King Saud University in Riyadh. Two other nanotechnology institutes are also planned, for King Abdul Aziz University in Jeddah and the King Fahd University for Petroleum and Minerals in Riyadh, at a cost of US$3.2 million each.

B. Arab universities' network for science education

To promote science education, Arab countries must identify leading science education institutions in the region that focus on science, technology, and innovation—especially in the scientific fields mentioned in the Arab summit decisions. Also, as in the case of the network of science and technology excellence centers, a review of projects in progress must be carried out. The United Arab Emirates has announced plans to establish the Dubai International Academic City, a higher education institution that will comprise universities and research and development centers from both developing countries, such as India, Iran, and Pakistan, and industrialized countries, such as Australia, Belgium, and the United Kingdom. Also, plans for a science plaza in Abu Dhabi—the Plaza of Intelligence and Innovation City—will promote science-related activities and include a research center for space sciences, a space and science museum, and an academy for math and science teachers.

An Arab network for e-learning must also be established, to promote cooperation among Arab countries in online education. Plans for a "virtual university" that will provide African students with Internet-based training were unveiled on November 18, 2009, at the World Summit on the Information Society, held in Tunisia. The academy, a joint initiative of Tunisia's Borj-Cedria Science and technology Park and the United Nations University, will focus its teaching on water, the environment, renewable energy, and biotechnology. It is also intended to strengthen links between African scientists and research institutions, including existing centers for Internet-based learning, such as the UN Water Virtual Learning Center and the Kenya-based African Virtual University.

C. Arab intelligence system for promoting science investment

The shortcomings of science education systems in Arab countries have been highlighted by the lack of entrepreneurship and innovation in the region. Of the top 15 countries that have submitted international applications under the Patent Cooperation Treaty, not one is an Arab country. For innovation to take root, the golden triangle consisting of of academic institutions, governments, and the private sector must cooperate in doing business.

A number of Arab countries have already started to encourage the culture of innovation and competitiveness among businesses and knowledge-based institutions and to promote links between scientists at universities and R&D institutions and science parks in the region. The aim of these efforts is to facilitate the establishment and development of innovation-based companies through incubation and spin-off processes. An intelligence system containing scientific creative ideas could be transformed into products and processes. Models for such ideas might be produced to be presented to the private sector.

D. Arab strategy

A regional strategy based on all science, technology, and higher education strategies in the Arab world will be prepared.

E. Arab fund for science and technology support

A directory of all funds that have been established in the Arab world, such as the Arab Gulf fund for climate change and the Islamic fund for agricultural research and food, will be prepared.

F. Enhancing regional and international scientific cooperation

International cooperation in science must focus on China, Japan, European countries, and African and Islamic countries. A cooperation plan already signed between Arab

countries, on the one hand, and China and Japan, on the other, will be analyzed and activated. Because Arab countries are members of the African Union as well as the OIC, their science plans will be analyzed to prepare a road map of available opportunities for enhancing regional and international scientific cooperation for technology transfer.

2. Need-analysis-based long-term plan

The result of the first stage will used as a base for planning the long-term plan.

VII. Conclusion

The U.S.-based Brookings Institution published a study in 2009 indicating that although Arab spending on education was high, the quality of education did not meet global standards. Students performed poorly on international tests in mathematics and science. The study identified a lack of qualified personnel as the largest obstacle to innovation. The Brookings study also argued that graduates of Arab universities were inadequately prepared for jobs and that the links between science and markets among Arab nations were weak, hindering the commercial application of knowledge.

Arab states should not continue to be a group of developing countries forever, and getting to a higher status requires the improvement of their chief abundant resource: human capital. To promote the development of science capabilities in the Arab world, a number of steps must be taken.

First, companies should be encouraged to make training an integral part of their business plans and should be given financial support to help them develop and implement staff training programs. Next, because Arab countries produce an excess of graduates in conventional fields, higher education institutions should set up special programs to provide the private sector with a skilled scientific work force and should offer courses in science-based business. These same institutions of higher learning should also focus efforts on emerging sectors, such as nanotechnology, biotechnology, information technology, and renewable energy.

There is a need for small-business-oriented "enterprise training" and vocational guidance centers, as well as short-term training programs for skill acquisition and enhancement. Unemployment in the Arab world has reached 14 percent, and the number of jobless is estimated to be 17 million, many of them university graduates. The graduate unemployment problem in the Arab world points to a deeper, more serious and long-term issue: a higher education system that produces graduates who lack "soft skills" such as time management, creative thinking, and communication skills, as well as workplace readiness and experience.

The high unemployment rate also indicates a failure of businesses to absorb more graduates into training or internship programs and to commit to them despite their youth and lack of experience. To overcome that barrier, a higher education reform agenda must include policies to increase the quality of the higher education system and its ability to produce industry-ready graduates, as well as establish entrepreneurship programs at the university level to help graduates enter the job market quickly.

Close and productive links between industry and R&D institutions, including universities, science and technology centers, science parks, and incubators, must be established to encourage innovation-based business. This can be done by establishing a university-based intelligence system to promote science and technology investment. Such a system would screen science and technology information to pick up creative ideas that could be transformed into products and processes. In sum, by cooperating with the private sector to set up commercially viable science-based enterprises governments could lay the foundations for science and technology-based "home-grown" entrepreneurial ventures that will ultimately generate jobs.