International workshop on "Science, Technology, Development and Enterprise Creation : Exchange of Experience, Achievements and Challenges"

Rabat, Morocco, 8-10 June 2000

Summary Report

The workshop opening session was held under the chair of the Moroccan Minister for Higher Education and Scientific Research. The objectives of the workshop were highlighted by the UNESCO representative :

- as the first follow-up activity to the World Conference on Science (Budapest Conference, June-July 1999), the workshop aimed to focus on the exchange of experience concerning the implementation of successful research and development (R&D) policies and the application of science and technology (S&T) to meet societal needs, and to draw lessons from success stories ;
- the workshop also aimed at supporting the efforts made by Morocco in a wide-ranging reform of its education system, including higher education, as well as in strengthening and improving the effectiveness of its scientific and technological research for development ;
- the workshop could lead to the development of partnerships among countries and institutions, as well as to a network linking good practices and experiences in S&T application to social and economic development.

Afterwards, the Director-General of the ISESCO (Islamic Educational, Scientific and Cultural Organization), the UNDP (United Nations Development Programme) Representative and the Executive Director the Third World Academy of Science (TWAS) presented the activities of their respective organizations ; they stressed the crucial importance of science and technology development for all societies ; the accelerated pace of adaptation to new technologies and the subsequent need for innovation, and human resources develoment and capacity-building ; the world-wide trend to review the role of higher education institutions and universities in order to open them to the external environment and their societies. They also highlighted the need to anticipate change and of having a vision in order to use the emerging technologies at the service of social and economic development. They underlined the role of regional and international co-operation among scientists, technicians, engineers, research centres and universities, of North-South and South-South co-operation, with a view to spreading knowledge and technology, as well as good practices and successful case-studies of application of S&T to development.

Then the Moroccan Minister for Higher Education and Scientific Research summarized the main aspects of the wide-ranging reform of the country's education system (finalized in a Charter approved by the Head of State in August 1999), as well as of the higher education institutions and the science and technology research framework. In this regard, several key areas of R&D have been selected, poles or centres of excellence and competence have been defined so as to be supported by the government and private sector. These initiatives aim at improving the country's competitiveness at international level, while higher education reform focuses on the autonomy and flexible action of

the 14 universities, active participation of all stakeholders, quality of teaching and training, the overall aim being to make the university a training and research enterprise rooted in its social and economic environment. The creation of technology incubators is foreseen. Built-in evaluation mechanisms, as well as prediction and vigilance means, have been designed in order to anticipate mutations and propose the necessary adaptations. A National Commission for Higher Education Coordination will be set up. The Minister who mentioned the new role to be devoted to his Ministry once the reform is in place, raised two key issues to be submitted to the participants' reflection :

- the adequation between training and employment ; in his view, the university should act on employment and not be passive, as it is to become the main tool for development, with all the necessary interactions with society ;
- the role and utilization of information technologies in all training and education processes (this wave of technologies may become a burden for the teacher rather than alleviate his/her task). He advocated the creation of a research centre in Morocco to study this key issue.

Panel I

The cases of Jordan and Tunisia laid emphasis on a radical change in science and technology education, formal and informal ; on a reform of the methods of teaching (student or learner-focused and not teacher-focused) ; and on foreign language capacity and mastery.

In addition, in Jordan, it is worth mentioning the removal of customs and tariffs on technologies ; creation of a competitive environment ; privatization and free enterprise approach in both education and R&D.

The African Regional Centre of Technology, in sub-Saharan Africa, illustrates a multiple action on technology-policy choice (with advisory services to facilitate this choice), training, pilot-scale technology development and then creation of technology incubators with a view to setting up small and medium-sized entreprises ; in addition, information and data-base creation was also an important area of action. Networking R&D institutions is a preferred and effective method for implementing the Centre programme in agro-food, energy and information technologies.

Panel II

Another regional example is that of Latin America, which has been described by many indicators of S&T showing its weaknesses, but also some ways for success, particularly through regional and subregional cooperation in S&T. There are examples at national level, but also at institutional and enterprise level, of good practices towards the application of S&T to development and to improving economic performance (overall or in some niches).

The case of Chile was described to show some of these good practices and successful achievements in several areas (mining, aquaculture, horticulture and fruticulture, banking services), that can be related (more or less directly) to investment in R&D and to a forerunning S&T policy. The role of the private sector, as well as of a liberal economic approach, the various sources of R&D funding, the quality of research and higher education in some areas and places, have been underlined.

Panel III

The participants listened to two speakers on the Finnish and Dutch experiences. Regarding Finland, the emphasis is laid on education, research, know-how, expertise and innovation, as well as on international co-operation, due to the lack of natural resources. The universities provide education based on research. Each Finnish university has a broad spectrum of disciplines and areas, with

peaks of excellence (21 university-level units for 5 million inhabitants). Funding is provided by the Ministry of Education (basic research), Academy of Finland (on a competitive basis), Technology Development Centre under the Ministry of Trade and Industry (for applied R&D, in the form of grants). High investment in R&D : 3.2% and up to 3.5% (in 2004) of GNP, 70% coming from the private sector and 30% from the public sector. 25 centres of excellence, submitted to peer review and evaluation before any new stage of activity. There is a technology and innovation-transfer chain, from the universities through S&T parks to industry and company incubators, with a built-in evaluation process.

The Finnish universities therefore work closely with their economic and social environment, involving natural, social sciences and humanities ; they have their agency for patenting and licensing ; they cannot yield to market only, but serve both national and international development.

Regarding the Dutch experience, the figures and S&T indicators are good, more or less like those of Finland. A word of caution about the fact that industry cannot be expected to finance university research heavily (4% to 5%). The share of the five biggest companies in R&D has decreased to 40% - 45% from 75%, but that of small and medium-size companies should increase or improve.

A number of changes and endeavours are made in the Netherlands to improve the R&D output and application to generating economic and social wealth, i.e.

industry-public research partnership, through contacts rather than contracts ; programmes instead of projects ; a two-way process between two worlds with their specific language and objectives ; generic measures such as tax cuts and incentives; intellectual property rights; scientific parks and technology incubators; science curriculum reforming ; gender approach (increase in female students in technology areas) ; foresight and priority setting.

The speaker gave examples of partnerships, e.g. 2+2 scheme, and he suggested the following measures that could be useful for developing countries :

- indicators and foresight mechanisms ;
- identification of the existing technology base ;
- regional systems of innovation ;
- linkage of capacity-building to relevant development programmes (i.e. societal challenges and economic development).

Panel IV

The overview of the Asian experience shows that the targets set forth in 1968 at the First Conference on Science and Technology, CASTASIA I, convened by UNESCO, were still to be reached by some countries, e.g. the target of 1% of GDP devoted to S&T R&D has been reached by Singapore but not by Indonesia (0.3%). However, S&T is receiving a rather high priority by the top political authorities. If some countries are doing rather well, Asia must reinvent itself after recovering from the 1997 economic crisis and draw as much benefit as possible from R&D in S&T. For instance, in the technology arena, some can be bought, but some should be generated locally; from technology transfer, we should move to science transfer, e.g. in Singapore ; in Hong Kong, the limit of buying technology should be challenged.

In Malaysia, in order to add value to Malaysian products, mainly agricultural commodities like palm oil, rubber, cocoa, the National Industrial Technology Development Plan of Action is being implemented according to a number of strategic thrusts, namely : leading R&D institutions such as the Palm Oil Research Institute of Malaysia (PORIM), the Biotechnology Directorate, the Artificial

Intelligence Centre ; increase in R&D within the private sector so as to adopt, improve and widely disseminate technologies, and enhance market-driven R&D ; creation of technology and science parks ; building competence in specialized technologies, such as medical and health-care technologies ; strengthening institutions and mechanisms for continuous development and elevation of the technical proficiency of the human resource base ; spreading of S&T culture.

In addition to the revision of Malaysia's S&T policy as of August 2000, R&D is being carried out in priority areas, such as agro-industry, environment, services, health, manufacturing, engineering and information technologies ; several schemes to promote R&D are in place, like the grant scheme. A number of challenges exist : finding the right mix of basic and applied research and technology ; infrastructure development ; international collaboration ; funding mechanisms of R&D.

Regarding the situation in Thailand, the information provided reveals a number of weaknesses : there are gaps and incomplete knowledge ; a system of knowledge generation and management is needed, as we have to increasingly deal with globalization of knowledge goods and to rely less on material goods; the competitiveness of the country is poor, partly because of a low record in S&T and sustainability ; the S&T indicators are not satisfactory, in comparison with other Asian countries.

Consequently, technology and management development is the key to improving Thailand's competitiveness, as well as innovation development, continuing education and foresight. The creation, a world first, of the APEC Centre for Technology Foresight is a milestone in the road to improving competitiveness.

In the Republic of Korea, over 40 years, there have been important investments in S&T R&D, resulting by the early 1990s in good indicators with respect to the percentage of GDP devoted to R&D and to the share of the private sector in R&D investment. During all these years, the key for success has been the transfer or import of technologies and their efficient adaptation to the production of exported goods ; the current challenge is to move from this 'old model' to a new model - i.e. a paradigm shift - and to generate technologies locally for producing knowledge- based goods and competing successfully on international markets.

Panel V

This panel was devoted to the Role of Development Banks. In a brief introduction, the Director of the Development Banks Division, UNESCO, recalled that practically all multilateral Development Banks retain the same objectives of fostering economic growth, poverty reduction and environmental sustainability. Since scientific knowledge and technological innovation are central to achieving these objectives, what are the roles of Development Banks and international organizations in enhancing the interface between universities and industry ? In particular which aspects of the difficult task of putting in place a science/university/industry interface would benefit from external funding and how do we go about formulating programmes for such financing?

The representative of the World Bank presented the current efforts to "mainstream" science and technology issues into World Bank funding. The rationale behind these efforts is that knowledge is the most important factor in raising economic growth and the standard of living. Knowledge has an impact on economic development through a country's national innovation system. The Bank has been supporting strong investment in human capital (basic education, science literacy and secondary education, scientific and technological education and training at undergraduate level. The next policy will complement these efforts by opening a new window to finance self standing science and technology loans and grants that would support the aspects of a national innovation

system not covered by the Bank's existing programmes. The principle instrument to do this is the Millennium Science Initiative (MSI).

MSI is an umbrella for new lending through which the Bank's client countries can borrow to improve their science and technology capacity. While MSI projects would necessarily vary according to the countries' specific level of science and technological development, they will all provide targeted support for research excellence, human resources training and creating linkages with partners with the international scientific and technological community, as well as in the private sector. A draft version of the Bank's policy on "Promoting Science and Technology for Development": The World Bank's Millennium Science Initiative" was provided.

The Director at the Islamic Development Bank (IsDB) outlined the IsDB's guidelines for supporting programmes in its Member States, namely national ownership, sustainability, leap-frogging the economic and technological gap, promotion of technology transfer in the formulation and implementation of projects. It has set up a Committee on Science and Technology, supported by an external advisory panel composed of eminent scientists. The IsDB is now willing to consider new modes of strengthening the scientific and technological capability in its member countries through the financing of S&T research and the patenting of innovations. These efforts would complement its ongoing activities, such as TA grants, high-level fellowships in S&T, etc.

Panel VI

Regarding the role of universities and higher education institutions in S&T innovation for development and more specifically in the 'triple helix' government-universities - enterprises, the speaker emphasized that universities had no more the exclusive role to generate knowledge ; the latter as well as creativity may occur everywhere. He also emphasized the importance of the time factor, when reviewing the measures aimed at creating economic and social wealth, through S&T innovation, the creation of jobs and enterprises. There is no wonder recipe and therefore solutions should be adpated to the prevailing conditions, e.g. those of a young developing country, where half of the population is less than 20 years old and which needs to create jobs and enterprises. Efforts should be made to increase awareness and to prepare the ground for introducing S&T innovation.

The speaker highlighted two aspects :

- give priority to young people, who should know that creativity is not exclusive of any age ; entrepreneurial activities should be developed in universities and higher technical schools ; as an example, in the Ecole des Mines of Paris, the number of enterprises created by students has increased to 20 in one year, and more than 30 patents have been filed ; consequently, it is rewarding to request the students to have a personal project or a collective project in an innovative area ; they should also have the right to fail if the project does not achieve the expected results, and start again ; the crucial issue is to create a dynamic approach in the young people's mind ;
- although the education system selects people on the basis of granting degrees, there are people who have no degrees, but have projects in many areas ; consequently, one should also care about those who have promising projects.

The following speaker highlighted , in the case of Finland, how important it was to have a mind-set, shared by government, enterprises, academia and people, so as to promote technological innovation and increase competitiveness.

Recalling that the goal of an effective S&T policy is to disseminate the good practices, the speaker stressed the three perspectives that should be taken into account in this approach : the individual

perspective (based on societal values, the role of an education focused on the learners, and the need to work together) ; the company or enterprise perspective (related to human resources quality and professional development) ; and the university perspective (linked to the creation of knowledge and effective technology management).

Finland ranks third in world competitiveness and this is the result of a long historical development (creativity to survive in a harsh environment), and of a consensual and continuous emphasis on S&T and government commitment to that policy. That is why the percentage of GDP invested in R&D is among the highest in the world, and the share of the private sector and public sector in R&D investment reaches 70% and 30% respectively.

The cornerstones of knowledge generation and enterprise creation are : life-long learning, sharing and dissemination of knowledge, transfer of technology and steady investment in R&D. The overall objective is to create a learning society through a national process. Consequently, there is a need for a policy and foresight, which are in the hands of a group of 17 members of the Finnish Parliament. There is also a need to develop and apply information and communication technologies innovatively, and to analyze their impact on society within a decentralized framework and under healthy competition (e.g. there are 100 telephone companies operating in the country within the scheme of decentralization).

The last speaker reported on an experience conducted in Morocco and concerning interactive seminars of company executives and scientists, with a view to sharing experience and views on management in today's world. The conclusions drawn from this kind of approach were that complexity must be tackled with humility (as we do not know everything), leave certain freedom and creativity in order to find the appropriate solutions to technology generation and management (as there is no universal solutions) ; the enterprise managers shoud change their vision of the university, but the latter must also change its own vision.

The Moroccan case

With respect to S&T R&D , Morocco has now a legal and policy framework, with three major objectives :

- restructuring, organizing and co-ordinating S&T, as well as taking measures to best use the means available ;
- definition of six priority areas ;
- funding of R&D through a special Fund for R&D, and a percentage of the overall revenue from concessions granted to companies involved in water and electricity distribution, 1% from the revenue of the first telephone license, 1% of the capital of privatized Maroc Telecom.

Now Morocco devotes 0,3% of its GDP to R&D, i.e. US$ 100 million ; at the end of the five-year plan, approved early June 2000, the objective is 1% of GDP ; the plan will make available US$60 million for improving R&D infrastructures and equipment.

In addition, the European Commission (EC) agreed to sign an agreement with Morocco in order to carry out a qualitative evaluation of Morocco's R&D potential. The medium-term goal is to participate in the EC research activities.

The private sector's participation in R&D is very low (less than 1% of the overall R&D budget). There is an R&D association which strives to develop partnerships between the private and public sectors.

There is the asset of 13,500 full-time teachers-researchers in Morocco ; poles of excellence exist, as well as the will to promote R&D by the government and diversity in the R&D system.

An example has been given in the area of nuclear energy for peace, where there is a regulation framework, the training of a competent workforce and the identification of areas of application.

The participants made a number of suggestions aimed at facilitating and fostering the implementation of the S&T R&D in Morocco.

- A steering committee, including international experts, may be constituted as a multidisciplinary co-ordinating body, in order to supervise the implementation of the plan of action concerning the reform of S&T R&D, with a task force approach, following a precise schedule and including a training component for acquiring a managerial know-how. The steering committee will work under the government leadership.
- Building on Morocco's comparative advantages, the implementation of the new scheme of S&T R&D should focus on higher investment into the relevance and quality of education (because of the trend towards a knowledge-based society) ; competition for quality is considered healthy as well as the acquisition of an entrepreneurial spirit.
- There is a need for a strong economic and political support to the S&T R&D reform. Following the example of Brazil, it has been suggested to create a " Supreme Council for S&T " , chaired by the Head of State and comprising the key ministers. It is also proposed to involve the best scientists and brains to provide an unbiased advice on S&T. This will be the role, among others, of the Hassan II Academy for Sciences and Technologies.
- Round tables involving government-enterprises- academia for effective interaction and outcome may be organized at the national level, but also with a view to examining regional issues and to ensuring the continuity of the 'triple helix' approach.
- Promotion of competitiveness among universities, particularly in selected fields of expertise ; the achievement of international standards of quality should also be the goal of S&T R&D.
- Creation of a National Innovation Committee. Emphasis on science and technology education, assisted by information and communication technologies.
- Donor agencies and funding institutions should also be called for to change the current traditional position vis-à-vis higher education and S&T R&D.

Conclusions and lessons drawn

The following conclusions can be drawn from the panelists' presentations as well as from the subsequent debate. These lessons can be considered as recommendations to the national relevant bodies and authorities in their endeavour to promote S&T R&D and increase its contribution to economic and social health.

1. Policies and measures conducive to innovation throuth S&T R&D, technology generation and management.
    - Creation at the highest government level of a small unit or task force, in charge of supervising the implementation of the S&T policy, designing the incentive measures towards this aim and removing any barrier or obstacle.
    - Increase in synergy between public and private investment in innovation.
    - Fiscal allevation for R&D expenditures by enterprises, in particular if they are channelled through universities.
    - Targeted programmes providing matching funds for university-industry ventures in fields selected through a national priority-setting exercise.
    - Administrative framework enabling universities to use extra-budgetary funds more flexibly.

- Technology-transfer structures such as incubators and provision of seed money for the commercialization of R&D products.
- Setting up of centres (or poles) of excellence or co-operative university-industry research centres, i.e. the so-called triangle or 'triple-helix' model for government-industry-university partnership.

2. Roles of universities and higher education institutions.

   The 'triple helix' model entails the revision of the roles of universities :

   - in addition to their conventional role (teaching, storage and transfer of knowledge), universities have an increasing social responsibility ; they should open themselves to the community, particularly towards the 'regions' within the framework of national decentralization ;
   - the universities are also responsible for creating knowledge as well as a scientific and technological culture ; without the latter, there is no firm basis for S&T R&D at the service of society.

3. Technology import and adaptation

   This is often the first stage of S&T R&D, which can be very successful in terms of output. An important factor is to monitor and control the quality of the commercialized products. Quality control can be carried out at various levels of sophistication depending on the nature of the commercialized product, and through a university-industry partnership ; the universities, even the less-advanced ones, can be involved in developing low technology options for quality control, suited to a local or regional setting.

4. Technology deepening or dissemination.

   This can be done from the centres of excellence, or those involved in technology import and transfer. This stage of dissemination and deepening can lead to another stage of knowledge and technology creation.

5. Technology scanning.

   Universities or specialized R&D centres can select the most appropriate technologies for national development, thus playing the role of a screening body or filter, before technologies are transferred and disseminated.

6. Technology foresight.

   A specific body, centre, unit, placed at the most appropriate level (e.g. parliament, government highest level) and related to the R&D institutions, should conduct foresight or prospective studies on technology generation and foreseen impact, or on emergent technologies, regional systems of innovation (after identifying the existing technology base).

7. Revision of current bilateral and international co-operation schemes and modalities, to better suit the needs and R&D situation of the aid-receiving countries (e.g. 2+2 Dutch scheme, where one country and one company from the North co-operate with one country and one company in the South ; 1+1+1, where, as suggested by Morocco, one country from the North, one country from the South and one intermediate country will co-operate in S&T R&D).