

Education, Research and Innovation for Sustainable Development: a Review of the G8-Unesco Forum

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Abstract. The G8–Unesco World Forum recently held in Trieste, examined the relationship between knowledge and sustainable development, focusing on the gap between industrialised and developing countries. In reviewing the proceedings, we provide some comments on the issue of turning the broad ideas discussed during the Forum into concrete actions. Despite being the Forum largely interdisciplinary, important aspects of knowledge were not explicitly considered: namely humanities and social sciences, as well as indigenous knowledge. The focus on research in ‘hard’ sciences did permit a thorough discussion of a number of crucial issues, but found its limits when ideas had to turn into actions. This is particular important for sustainable development, when the community involvement at regional/local level is key in obtaining feasible solutions. In order to help promote knowledge creation and dissemination in practice, this paper will concentrate on highlighting a common ground of agreement, from different perspectives, and what ought to be done in the future for promoting a better match between all knowledge components and sustainable development.

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Introduction

The G8–Unesco World Forum held in Trieste on 10-12 May 2007¹ brought together some 800 people from research, academia, government and industry from about 60 countries. Participants were invited to discuss how Education, Research and Innovation - the three components of the so called ‘Triangle of Knowledge’ - could be integrated to build a road map leading to sustainable development² for future generations.

The area of agreement expressed by the Forum can be summarised as follows.

Knowledge is key for sustainable development. The North/South gap is knowledge-related, particularly for technological and scientific developments. It is essential to explore partnerships in science and innovation to meet the basic needs of developing countries. A multidisciplinary approach is required to integrate natural sciences with social sciences and humanities. Politically, there is a strong need for mutual recognition, in a spirit of cooperation among cultural, linguistic and historic diversities. If the knowledge divide is allowed to widen, the discontent of some parts of the world will eventually put the creative growth of all societies to a halt, or worse. Therefore, there is great urgency for action.

The main point is, of course, how to turn broad ideas into specific policy measures. To address this question, it is our opinion that one has to look first at facts, then define realistic policy targets, and finally set up concrete measures of actions. This paper is thus organized as follows. In the first ten Sections we summarize the discussion of each topic that was held during the Forum and provide a few comments along this line of reasoning. In particular we will highlight to what extent the questions that speakers were asked - reported in italics at the beginning of most sessions - were properly addressed. The last Section provides some conclusions and considers a set of recommendations, as they emerged during the floor discussion, and in the immediate follow-up of the Forum.

1 Partnerships to develop a global innovation society

What is the role of universities in developing innovation and entrepreneurship? How do we develop best practices on knowledge-based development and private-public partnership to facilitate global knowledge dissemination? How do we identify barriers among relevant

sectors and ways to overcome them to promote combined investments in education, research and innovation?

In setting the floor for the discussion, prof. Hans Weiler, from Stanford, suggested that both competition and cooperation are required, together with the construction of cultural affinities and co-operative research, to develop a global innovative society.

As a representative of the Italian Association of Entrepreneurs Confindustria, Pasquale Pistorio mentioned some successful cases of cooperation between universities and industries. Yet a weak connection remains between these entities, due to the high share of small and medium enterprises (SME) in the Italian economy. Large firms seem to behave, indeed, in line with European standards, as they are able to pick the best Universities as R&D partners. Nor can one blame entirely the sector composition of the Italian economy, which is notoriously made of traditional sectors, for a low propensity to collaborate with universities, as innovation nowadays apply to all, especially traditional sectors. Policies to help improving this collaboration have been suggested by Confindustria, and partially endorsed by the Italian Government (i.e. tax rebates for cooperative R&D, cooperation for large projects). But no answer is provided to the role of universities, nor to how to lower the barriers among sectors to promote combined investments in education, research and innovation. As for global knowledge dissemination, one is left to wonder what policies can be envisaged to help SME to access knowledge that has been publicly promoted. Particularly when, how and to what extent, knowledge can be allowed to produce new knowledge by different uses and applications.

The role of universities and the relation between higher education and business was discussed by the Rector of the University of Bologna, Pier Ugo Calzolari, who stressed both the shortage of private and public funding as well as the absence of a severe procedure to guarantee a good match between the two. According to Calzolari, in order to help create a global innovation society, universities should: 1) facilitate a higher circulation of people, both domestically and internationally; 2) rely on more autonomy, but provide financial accountability; and 3) maintain their long-term research mission together with shorter, business oriented, research activities.

Prof. Dmitry Livanov, Rector of the Technological University of Moscow, reported on how Russia is trying to turn public/private partnership on R&D into a benefit for all, by creating a friendly environment for business innovation. Four main avenues are considered in this respect: 1) investing in mega-projects on a national scale in key sectors, such as nanotechnologies, information and communication technologies (ICT), life sciences, biotechnologies, with a minority participation of the government; 2) setting up comprehensive Federal Programs on R&D; 3) launching a number of tax free Special Economic Zones; and finally 4) creating a National Venture Company that will provide minority participation with 1 billion € in the next two years.

The Vice Minister of Education of the People's republic of China, Mr. Zhang Xinsheng, focused again on education and highlighted how China faced the challenges of a fast growing economy by matching the quality of growth with the quality of education. For universities, a multidisciplinary approach, inter-university collaborations, and an emphasis on basic research was associated with dramatic positive results. Science Parks and Incubators were also mentioned, together with policies to form clusters and private/public partnership in R&D, in order to enhance North/South and South/South cooperation.

In his summary, Carlo Rizzuto, president of Elettra Laboratories, highlighted the key points of the session, focusing on the role of universities, "highly strategic for the development of innovation and entrepreneurship". This role is actually implemented through several channels, the most effective being education, knowledge sharing, and knowledge transfer. These channels should be enhanced by appropriate long-term policies, the most effective being the evaluation of education and research as an instrument to increase excellence, and the growth of cultural affinities among people, based on sharing norms, increasing people mobility, and widening territorial openness. "In a globalized world, a region should aim at *capturing the flow* and be able to allow changes rather than close its borders.[..] The specific barrier to be overcome within and around the universities is the disciplinary fragmentation".

2 Education in the Knowledge-Based Society

How is it possible to innovate education systems up to the requirements of a global knowledge-based society? How can we identify the best models of education governance, teaching and management?

In assessing the role of the Global Action Plan in achieving Education For All (EfA) – a target up-dated in the 2000 World Education Forum in Dakar³ - Mark Bray, from UNESCO, reminded us that while elitism is needed for a better match between research and innovation, equity and free access to education is to be pursued in the first place. Education for the marginalised is as important as education for the elite. Recent data confirm that pre-primary and primary school are slowly spreading and gender parity improving; yet the 2005 targets have not been achieved, as 1/5 of the world's adult population remains illiterate and 77 million children still don't attend school. To fully implement the Global Action Plan the speaker argued that we need a division of responsibilities, a harmonisation of action in key areas, and more focused strategies.

Stefano Fantoni, from SISSA, pointed out the importance of Third Level Education (PhD) for the optimal creation and utilisation of science in innovative activities, both for the economy and the society as a whole. Universities should keep creating and disseminating fundamental research as a source of technological and social innovations. In insisting that Education and Research must be closely linked, at higher levels, he recalled a number of basic principles that should inspire concrete actions: high quality of education, widespread partnerships, open access to scientific information, internationalisation processes, interdisciplinary openness, and finally, intense cooperation with developing countries.

By stressing that Globalisation is more than the internationalisation of markets, the Federal Minister of Education of Germany, Ludger Viehof, recalled that education is both a prerequisite for the supply of high qualification and a key to social cohesion, aimed at mitigating the consequences of globalisation (such as fragmentation and segregation). OECD indicators show that countries investing in education more heavily are those who benefit the most from that choice, both economically and socially. But money is not a guarantee for good results. Institutions must be responsive, flexible and effective to societal demands. Globalisation leads to more competition: for talents, for financial resources and for

recognition. Educational institutions must react accordingly and allow reciprocity in the exchange of scientists, researchers and scholars. A higher brain circulation is needed.

The Rector of the University of Udine, Furio Honsell, argued that universities have to become open institutions and factories of human capital for regional development. Both researchers and students must understand the economic and management issues behind their activities, develop entrepreneurial skills, and be aware of how to pursue capitalization of research. The University of Udine has developed a strategy for increasing the entrepreneurial skills of its students by a number of initiatives, e.g. teaching patents-filing, launching business-plan competitions, and setting up a technology park and a spin-off incubator.

In her summary, Hebe Vessuri, Head of the Department of Science Studies of the Venezuelan Institute of Scientific Research, stated that there is no disjunction between the global and the local perspective, but a continuum that includes strategic anchoring to national innovation systems. Public policies must have a multiple approach to respond to a complex set of problems. When considering capacity building, for example, it is not only a question of science and technology. We must also enable local populations to improve their condition in connection with practical knowledge, and provide opportunities for all.

Unfortunately, priorities differ, as well as aims and methods. When resources are scarce, for example, one has to decide whether *equity* or *excellence* are to be pursued in the first place. Similarly, we need to decide to which *market forces* we want to refer: those that would suggest a better supply of inter-disciplinary skills, able to interact and sell to the market in general, or rather those that relay on self-help and 'home-grown business' to help the local territory to compete? So, this session is there to suggest that a number of political decisions need to be taken before education policies can be pursued.

3 Environment

How is it possible to develop an integrated approach for research, education and innovation to meet global environmental challenges, including impacts of climate change, air and water pollution, acid rain, rain forest destruction, hazardous waste and overpopulation?

This is only one question, but not an easy one, as it cuts across many different levels of analysis. Laura Marchetti, Under-Secretary of the Italian Ministry of Environment, provided a

first answer by advocating a new relation between ecology and economics, as a result of new models of consumption and production. A few principles lie behind this idea: 1) knowledge has a universal destination, yet knowledge creation is also a universal right and need to be defended; 2) knowledge transfer implies reciprocity, especially in relation to less developed countries; 3) a fourth dimension should be added to the triangle of knowledge: the concept of preservation of local knowledge, cultural diversity, and biodiversity. This is indeed a very important point that paves the way to the contribution of social sciences and humanities in solving many questions left open by the Forum. For example: how do we help new knowledge to be created by de-centralised utilization, rather than by centralised R&D expenditure? Or, how do we circulate the information about other ways to meet both basic and sophisticated needs, under a new philosophy of conservation and protection?

Focusing on knowledge management, Michael Osborne, Director of the OECD Global Science Forum, proposed an integrated approach to global challenges. Educational qualifications are only a “shadow measure of knowledge”. What we need is a holistic, interdisciplinary approach. First we have to identify the links among global issues: i.e. climate, energy, population, health, economic growth, national security, poverty. Then we have to look at the dynamics of the systems and the social driver to change. To help create new dynamics, there are many business models for research purposes: private public partnerships (PPP), capital intensive research capacity, networking research on global scale, net-based tools (i.e. interactive social web). The best way to develop an integrated approach is to use a wide disciplinary set of approaches, involve different national perspectives, build consensus through formal and informal networks, and work media resources to spread the messages.

Lord Hunt of Chesterton - professor of Climate modelling in the UK - focused on the effectiveness, economic advantages and political support for adopting integrated solutions for the reduction of environmental risks. Scientists and international organizations can improve their action for sustainable development firstly with information about environmental risk, secondly by providing focused forecasts and warnings, thirdly with technology and social organization for reducing impacts of natural disasters or climate extremes; finally by reducing the hazards themselves, the greatest being global warming. This requires international agreements, huge investments as well as people being encouraged to make their own

contributions (e.g. with energy conservation). International organizations and governments need to explore new technologies to cut emissions by more than 50 % below current levels in the next 30 years. To this end, universities need to come up with new solutions to help research and education to address these issues, by integrating all sciences with technology.

Finally, Giuseppe Morsillo, Head of the Policy Office of the European Space Agency, made the connection between Space and the 'Triangle of Knowledge' and illustrated with many examples how space-based science can benefit humanity.

This section provides an integrated piece of analysis. By zooming-out, we can reach a better view and a more thorough understanding of a complex matter. But to follow its suggestions, we need to go back from the path we have been experienced all along the past half century.

4 Innovation and Society

How do we strengthen innovation culture? What role can the public sector play to accelerate innovation and raise citizens' inclusion and participation? What kind of governance is necessary to make innovation policies more effective in our societies?

This session is socio-economic in essence. Yet no scholars of these fields were invited, but rather eminent businessmen, top level scientist and technology experts: a promising choice for practical purposes. The Vice President of Microsoft, Umberto Paolucci described the efforts that his company is making in order to reach the 5 billion people who are not yet connected via Internet. In particular he mentioned a number of programs: e.g. the Unlimited Potential, aimed at helping 250 millions to find new jobs; a certification of teachers results in e-learning programs and a soft-ware donation program to students for a symbolic 3\$ fee. Overall, Microsoft is now developing world-wide Innovation Centres, which amount to around 200, and promote pro-poor public/private partnership on a world scale.

In talking about governance in converging technologies, at the nanoscale, Mihail Roco, from the American National Science Foundation, discussed their implications in expanding human cognition and communication, with positive outcomes in socio-economic indicators, and societal relations. A profound change of perspective is taking place, and this will affect policies for R&D investments and infrastructure, models of business organization, risk governance, personal security. After a specification of the risks induced by emerging

technologies, which will rise complexity, uncertainty, and most of all, will have unforeseen societal implications, Roco concluded by identifying four levels of governance of converging technologies: 1) adapting existing regulations and organizations; 2) establishing new programs, regulations and organizations to handle specifically converging technologies; 3) maintaining national policies and institutional capacity building; and 4) promoting international agreements and partnership.

In describing how science affects innovation and society, Robert Aymar, DG of CERN, underlined the importance of basic research, drawing from his organization's experience, which was responsible for the very existence of the world wide web, invented at CERN in 1990. In a nutshell, despite being 'curiosity driven', CERN is also a world patrimony for providing open access to scientific knowledge, and thus realising today's library of Alexandria.

Bruno Lanvin, from the World Bank, finally stressed that, though associated with rapid growth, inequality has increased with globalization. Yet, despite being ICT the core engine of globalization, the digital divide is less about equipment and technology - where we have to keep improving connectivity, competition and education - than about content and value - where we need to share knowledge across borders and allow information (and thus value) to be created in every part of the world. If winners are 'permanent innovators' and 'continuous learners', all economies will strive for knowledge, putting human resources back at the centre of competition and development. In this world, all stakeholders will need to accept new roles, aimed at solving the possible conflict between public and private interests, and between producers objectives and consumers needs, in a new private/public dynamics.

In commenting the results of this session, though, it is hard to find assonance among the speakers. But this is probably due to the heterogeneity of the questions and the different perspective of each participant. As a whole, we are getting a vast set of examples on how to deal with the promotion of an innovative society, but scope remains for connecting all dots and find out how knowledge can be disseminated, under new rules, in the struggle between private appropriation and public supply.

5 Health

How do we develop integrated healthcare approaches to meet the challenges arising from aging populations, environment deterioration and possible global pandemics? What is the impact of intellectual property and health care issues on developing countries? Which are the critical areas of research?

Pratap Reddy, founder and executive chairmen of the Apollo Hospitals Group in India, said that his objectives were to bring “quality care at effective costs”, while emphasizing patient-centric care. The Group has so far treated 14 million patients, conducted 59,000 heart surgeries (with a success rate of 99.6%) at 1/10 of the US cost and introduced telemedicine for the first time in India. Its experience is a brilliant example to answer the first question.

Francisco Baralle, DG of the International Centre for Genetic Engineering and Biotechnology (ICGEB) noted that “basic research should be encouraged in medical science and genetics” and that scientists from developing countries should be provided with knowledge on intellectual property matters to help ease-up North/South collaboration. At the same time we should simplify technologies without lowering quality.

Giorgio Tamburlini, from Burlo Garofolo Hospital, in Trieste, provided insights into the global situation of health care and the contribution of biotechnologies to health. He stressed that an integrated approach needs not to be reinvented and made universally accessible, with priority given to primary health care and the involvement of local communities. Talking about health strategies he suggested to increase the demand for health through education, to address directly under-nutrition, poor reproductive health and lack of safe water, through cross sector action, and to support a comprehensive health system (with finance, staff and management).

6 Energy

What possible energy scenario exists for the world of the 21st century? How do we develop an integrated approach involving education, research and innovation to solve the energy challenges of the century?

Opening the session, Giovanni Manfredi, Italian Plenipotentiary Minister for Energy Issues, emphasized the need to increase fuel efficiencies and the development of alternative energy technologies. In the wake of a dramatic increase in the demand for energy, an issue underlined

by all speakers, Lawrence Kazmerski, Director of the USA National Centre for Photovoltaics, presented a series of possible scenarios for the availability of energy resources in this century and stressed the necessity of a breakthrough in 4th generation photovoltaic devices.

Isao Yukawa, President the Japanese Kyocera Solar Corporation, underlined that renewable energy could be the answer for sustainable development. He presented a series of solar applications particularly suited for developing countries: from village electrification to mini-solar centres. Solar energy can also meet many of basic needs: from water pumping to health care. “There is unlimited solar energy available on the planet, if technologies are developed to harness it”, he concluded, thus revealing a huge scope for policy measures.

Evgeny Pavlovich Velikhov, president of Russian Research Centre Kurchatov Institute, stressed that “only international cooperation can help us meet our increasing energy demand”. An integrated approach is provided, to solve the energy challenge of the century, by Ali Saygh, chairman of WREC. After a few considerations on the inertia of our current habits, he summarised the situation of all our sources of renewable energy and concluded that “renewable energy will meet the challenge”. By the end of the century, we expect 90% of our energy needs to be renewable, 70% of which will come from photovoltaic technology, suited for all, and particularly for developing countries.

In the end, we are left with the impression that new, simple, de-centralised technologies, together with major scientific break-through, will help us meet an increasing demand for energy, if only blind politics and vested interests would not get in the way. But the silence on why we are not taking the right direction, so far, does not spell optimism for the near future.

7 Government

How is it possible to leverage public expenditure in attracting private funding for university research, and enhance cooperation between universities and industry? How can governments cooperate with the private sector in the development of innovative, high quality education, research and innovation systems? How can governments promote dialogue and synergies with business, higher education and labour to articulate sound policies and develop needed resources for higher education?

Fabio Mussi, Italian Minister of University and Research argued that, in bridging the gap

between science and politics there are reasons for optimism, as R&D expenditure tripled in 15 years. Yet the goals set in Lisbon in 2000 for the development of a European 'knowledge society' have not been met, and this is cause of concern.

Mosibudi Mangena, Minister of Science and Technology of South Africa, described his country's governmental policies to promote innovative thinking and innovation in science and technology. He mentioned a number of selective policies in key sectors (i.e. biotechnology, nanotechnology, ICT, space), the promotion of industry-university links, a series of tax incentives for private firms, start-up and seed-policies to help improve new ventures, and various funding devices. A very articulated set of measures that spell success for the future.

According to Janez Potocnik, European Commissioner for Science and Research, "there are global challenges that are not confined to one specific area and therefore we must really work together - this is the value of a "knowledge society." The way EU deals with this problem is mainly by trying to overcome barriers and fragmentation, and by reforming EU institutions to better cope with coordination. Besides countries agendas, a common area of interest concerns intellectual property rights, taxation, subsidies, regulation, finance, and technology.

In stressing that high-tech is key, Nobel Laureate Carlo Rubbia noted that Italy lags behind US and Europe in research expenditure, both public and private. In trying to provide some economic considerations, he first argued that global competition is irreversible, an opinion that is shared by most people. Then he suggested that knowledge is more important than capital. It follows that, as there is lack of continuity in R&D efforts, despite a fast acceleration of innovative processes, today a country needs investing in R&D to attract foreign direct investments. And as there is a high correlation between R&D and innovation, we must develop key-sectors, as driving forces for new technologies. How we do this, and which key-sector are to be developed by the North and the South respectively is not specified.

Nobel Laureate Martin Perl talked on the education of researchers, and advocated a minor burden of work for the students, together with a reduction in the length of their studies.

So, while two Nobel laureates focused on specific issues, it was up to Mangena to address all questions at once, by providing concrete examples on how South Africa is dealing with financial leverage and private/public cooperation; and to Potochnik to reminded us that while a common policy is under implementation on critical issues, Europe has to make the effort to

overcome fragmentation and national visions.

8 Sustainable development

In addressing this Session, which led to the conclusions, Hans van Ginkel, Rector of the UN University of Tokyo, said that “all types of education must be transformed to prepare the next generations”. Education for all, and education for sustainable development, are but two sides of the same coin. Focusing on sustainable development, he added that “all three elements of the ‘Knowledge Triangle’ must be developed in harmony with each other and the specific natural, social and political context, as well as the economic and cultural environment. Knowledge is indeed an inseparable part of sustainable development. All poverty reduction strategies and plans trying to promote ‘self help’, should include proposals to strengthen education, knowledge and innovation capacities in that region. It is recommendable to create “home-grown” human and institutional capacities for education, knowledge development, preservation, and innovation transfer as well as the strengthening of specific innovation systems. ‘Twining’ with relevant institutions abroad and targeted ‘sandwich’ programs should be fostered in order to increase the pace of development and open-up opportunities for ‘leap-frogging.’

Exactly how this strategy is pursued is described by Atta-Ur-Rahamn, chairman of the Higher Education Commission of Pakistan. In stressing that children are the real wealth of a country, the speaker provided details on the very articulated and innovative framework that has been put in place in Pakistan to improve education, particularly at higher levels. This framework rests on six pillars, namely: 1) attracting the brightest by tripling salaries (plus research grants and tax rebates) for academics and researchers on merit-related principles with no seniority benefits; 2) training them by providing the widest infrastructure (free access to literature and sophisticated instruments, etc.) and a number of programs (foreign scholarships, domestic PhD, huge under-graduate programs); 3) using technology to leap-frog in key areas and create, for example, a virtual university with four digital satellites, which will reach remote areas of Pakistan and span through East Africa and Central Asia; 4) developing appropriate curricula in which basic and applied science are not competing but rather integrating and Universities are linked both nationally and internationally; 5) enhancing access to ICT: a

major success after 2001, with figures skyrocketing for internet users; and finally 6) promoting distant learning through international partnerships and linkage with international top universities consortia.

Going back to more general considerations, Dimitri Piskounov, DDG of UNIDO, stressed the importance of the *functional literacy rate* (literacy that can be usefully employed in the economy) to help turn learning efforts into a 'knowledge capability'. This is indeed what will help countries reversing the brain drain and create economically viable market niches, rather than simple aid or debt relief. This topic seems particularly important for Africa, which has lost at least 60.000 high-skilled professional last year. A focus on energy for productive use, rather than consumption, is also recommended, to gear UNIDO efforts into economic results. This latter suggestion was opposed in the discussion.

9 Africa

This special session on Africa focused on opportunities of scientific cooperation, at both the North-South and the South-South levels. In dealing with the main challenges posed to Africa (namely addressing sustainability, improving the output from research, and reducing the brain drain) Mohamed Hassan, ED of the Academy of Sciences for the Developing World, focused on six opportunities: 1) the promotion of cutting-edge technologies (such as wireless ICT, biotechnology, space science, and nanotechnology); 2) the availability of natural resources of a "different kind" (characterised by biodiversity, ancient knowledge and a conservation attitude) as well as of clean solar energy; 3) a renewed political commitment by African leaders (i.e. the recent decision of the African Union to spend at least 1% of its GDP in Science and Innovation, a figure already surpassed by a number of countries); 4) a greater commitment by G8 countries to build universities and Centers of Excellence such as the NEPAD Action Plan; 5) a renewed South-South cooperation, as with China, Brazil, India, and various networks and institutions, included TWAS and COSTIS; and finally 6) new commitment by African academies.

The round table that followed was held by four African Ministries of education, science and technology coming from Egypt, Kenya, Rwanda and Senegal. They offered testimony of a multi-facet reality: namely that of a continent that is still straggling, but finally showing signs

of development, with encouraging achievements precisely in the 'Knowledge Triangle'. A detailed Science and Technology Plan was set up in Egypt, focusing on human resource development and setting priorities to national projects in key sectors. Specific policy objectives have been introduced, in Rwanda, for the acquisition, the creation and the transfer of knowledge, in an effort to spread a culture for innovation. In any case, all speakers mentioned a list of actions and various initiatives in bilateral and multilateral cooperation in science and technology in key-sectors that is highly encouraging for the future. But - given the quality of the speakers and the discussion that followed from a vast floor of African leaders - most encouraging of all is the sensation that a top-level ruling class is developing, in Africa, with competence and vision, despite the heavy burden of the past and the present. Patrizia Sentinelli, deputy minister of the Italian ministry of foreign affairs, offered her conclusive remarks, stressing the political dimension of the entire debate, with particular emphasis on the role of the EU, and the position of Italy in that respect. Looking at Africa as a continent that is now developing its own strategies in science and technology, Sentinelli pointed out that poverty reduction strategies are to be principally based on *rights*: i.e. rights of access to key resources, such as safe food and free water, and human rights in general, particularly for women. To these ends, Italy is acting at various international levels, to help redefine cooperation in accordance with the non-dissipative spirit of Africa, and the opportunity to provide home-grown solutions to both domestic and global challenges.

10 The future

Introduced by Werner Burkart, DDG of IAEA, the final session focused on what can be considered the most outstanding issues for the future.

Edouard Brézin, former president of the French Academy of Science stressed the next energy challenges, namely the exhaustion of fossil fuels and the need to rely upon all energy sources. Yet, science and technologies might help reducing our energy needs and CO₂ emissions. Unfortunately there is no agreement among governments and people on how to do so. "We thus need social sciences to help pure and applied science to address the needs of society and settle controversies": an illuminating suggestion for a follow up of the Forum.

In order to maximize wealth in the long run - perhaps the best definition of sustainable

development - Roger Schjerva, the Norwegian Deputy Minister of Finance, delivered a presentation of his country's policies, as an example of how ethic considerations enter the picture of development. International cooperation was named first, followed by addressing climate change, ozone layer and pollution. Biological diversity and cultural heritage are also areas of concern, together with preservation of natural resources and protection from hazardous chemicals. Precise targets have been set up in Norway to this end. Furthermore, as oil doesn't always improve people's lives, Norway is there to offer a 40 years experience on how to reduce poverty and improve living conditions by gearing oil revenues towards development goals.

The world population growth, and the importance of new technologies in dealing with it, is the final theme discussed by Sir David King, Chief Scientific Advisor of the British government. In an impressive presentation on how we could effectively gain from a double-edge strategy of cutting the costs of energy waste and resorting to all energy means available, King confirmed the popular say that "we need all the tools in the bag". To help the demographic transition to 9 billion people, we need technologies to impact on food, health, water and climate change. But we have to re-gear our efforts to future needs. Yet, whilst global agreement on climate is necessary, it is also difficult for a number of reasons. For example, the existence of a free-rider problem (expressed by the single agent advantage of not honouring a deal); the persistence of huge differences among countries (in size, interests and visions); and finally the mismatch between the political perspective (typically short-term) and the societal perspective (typically long-term). At the end of the day, "the obstacle are not economical, but political and cultural".

11 Recommendations and conclusion

A few recommendations can be drawn, to conclude, from the Forum discussion. Although very general, they are worth mentioning as a first step for further actions.

It is absolutely clear that the G8 countries should setup and sustain a new framework for partnership with the developing world by connecting and integrating the three component of knowledge and gear them to sustainable development. Not only is this advisable for tempering the mounting criticism against the G8 approach to development issues, but also

because a new framework, if based on information-sharing and a mutual recognition among partners of different origins and cultures, will allow to create new knowledge, and therefore new value, by connections and inter-actions. A number of problems must be solved in the creation of new knowledge, the most important of which is probably the search for a compromise between *property rights* – which will impact directly on some knowledge creation - and *rights of access* - which will allow for its dissemination and further applications. This problem will need specific attention, in the future, to allow new knowledge, and hence new value, to be created at the user's level, rather than exclusively in the R&D departments of firms. In any case, sustainability requires the strengthening of education and research institutions. In cooperation with other international institutions, the G8 countries - it has been suggested - should support the establishment of 'Centres of Excellence for Sustainable Development' with the specific aim of integrating education, scientific knowledge and innovation world-wide, while, at the same time, making the most of all differences in the cultural environments. The Forum has shown that this is possible, as a new group of world-class scientist and politicians are emerging also in the developing world, where they want to remain and work, as witnessed by a number of initiatives. These Centres of Excellence should enable the exchange of ideas among educators, scientists and innovators both from developing and advanced nations, and foster cooperation among top-level institutions around the world. Many examples have been presented in the Forum on how to do this in practice, according to the context of origin, but also in the spirit of breaking some rules of the past. In particular, the G8 countries may rely upon Italy's long time experience in fostering science in developing countries through the international institutions operating in Trieste during the last 40 years and their regional and international connections. A further G8 initiative on the role of research and innovation on sustainability could be developed to create interdisciplinary programs and generate new partnerships. This is a turning point for those scientists who have been deepened and narrowed their field of interest without considering the broader environment; and also for those who have conceived partnership more as a source of value acquisition, rather than as an occasion for value creation and implementation. But to innovate along these lines we need first to create a common language among disciplines, topics, and agents who may have different aims (e.g. universities and industries). On the other hand, as resources are scarce,

priorities should be given to regions where investment in innovation for sustainability is likely to provide most leverage. Some participants advocated the idea that G8 countries could divert a portion of their public R&D expenditures to a 'Sustainability Innovation Initiative Fund'. Operationally, the funding could start at a low level of financial involvement and prioritize the building up of fundamental structures for science and innovation, according to explicit steps. To start and possibly implement this option, social scientist must be involved, to provide know-how, scope and methods. Political economy, in particular, should supply useful insight on how to deal with conflicting interests, and help shape an area of consensus for the policies of the future. The role of industries was also downplayed in the Forum, despite the presence of some managers among the speakers. An open debate would be useful, in the future, on how to deal with knowledge creation and diffusion from a social and an economic point of view. It is perhaps the lack of this perspective that, after agreeing on *what* we should be doing, misses the point of *how*, and *when*, are we going to do it. Finally, international support should aim at promoting context-specific solutions and build on successful local experiences, drawing from wide-spread evidence that knowledge is context-based and subject to a myriad of different applications, with unlimited potential for the creation of new value.

Notes

¹ The topics discussed here are available on the Forum website www.g8forum.ictp.it

² The term 'sustainable development' not only considers the limitation of the use of measures such as the gross national product (GDP) for assessing the well-being of a nation. It also embraces wider concern for the quality of life, as expressed, for example, by education attainment, nutritional status, access to basic freedoms and spiritual welfare. It also suggests that development policies should not seek short-lived gains, but aim at making development achievements last well into the future.

³ The targets were the following: 50% improvement in adult literacy; eliminate gender disparities in primary and secondary education by 2005, and achieve gender equality by 2015; improve all aspects of quality of education and ensuring excellence of all.

References

www.g8forum.ictp.it