Toward an Agenda for Mexico International Cooperation in Science and Technology[1]

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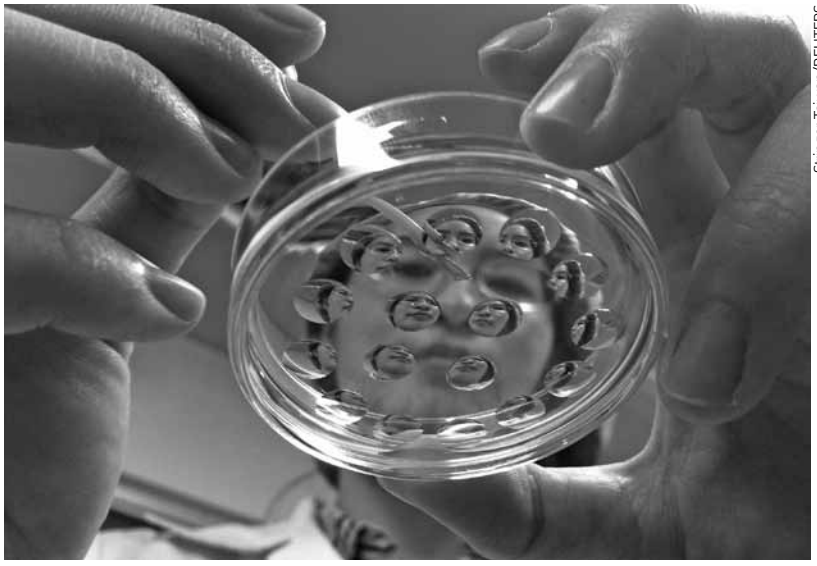

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Introduction

Today, the essential role of science must be taken into consideration as a driving force of economic development and social well-being in the globalized world. Development depends increasingly on the knowledge generated by scientific research and on basing public policy design decisions on that information. A knowledge-based society has the possibility of effectively resolving the very diverse problems it faces.

Mexico suffers from huge problems of inequality and a lag in many areas of development. However, as an emerging country, it plays a special role in the planet's geopolitical and economic spheres. For this reason it is fundamental that the country increase its capabilities in science, technology, and innovation and advance toward a knowledge-based economy that will allow it in the long term to resolve problems of health, food supply, care for the environment, and energy use, among other issues. This will only be possible if it recognizes the importance of science, technological development, and innovation.

To produce knowledge, not only the so-called "hard sciences" must participate, but also the social sciences and the humanities, given their capacity to systematize experience and history, investigate the past, unravel the present, and envisage the future. The social sciences produce reflection and global critical analysis from a complex perspective; above all, they make it possible to analyze the ethical, social, cultural, and political implications of scientific knowledge and its application, in addition to making it possible to link scientific knowledge and technological innovations to social and human development.

The social sciences are fundamental for designing, implementing, and evaluating public policies that lead to reforms to broaden freedoms and strengthen the rule of law; narrow inequality gaps; improve social coexistence; and create more just, democratic, inclusive societies. For that reason, science, technology, and innovation policy must be comprehensive, fostering an understanding of nature, the world, and the universe. From this broad standpoint, knowledge becomes the driving force for comprehensive human development, productivity, and competitiveness. However, Mexico still has a long way to go to achieve a policy in this field that would make it possible to sketch the country's priorities as a function of its most urgent needs and current capabilities.

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Some Data on Mexico's Position

Mexico has a geo-strategic position in the Americas. It is a cultural, political, and physical bridge between North America and Latin America and the Caribbean, as well as between the industrialized and emerging countries. This position is strengthened by the integration of the economies through the North American Free Trade Agreement (NAFTA), by its cultural wealth, which gives its voice greater weight in Latin America, and by the strategic partnership it maintains with Central America. At the same time, it is one of the biggest, most open and dynamic markets in the region.

According to data from the World Economic Forum 2012, Mexico is one of the world's biggest markets (11th place), and has a relatively consistent macro-economic system (40th), a good transportation infrastructure (41st), and an increasingly complex private sector (44th).[2] Despite this, its scientific, technological, and innovation capabilities do not correspond to those of a middle-income country or one of its international position.

Mexico's Special Science, Technology, and Innovation Program (Peciti) set as one of its main goals that the country would move from 58th place on the World Economic Forum's Global Competitiveness Index in 2006 to 30th by 2012. However, in the 2010-2011 ranking, it dropped to 66th place, and in 2011-2012, moved back to 58th. Finally, in 2012-2013, it ranked 53rd. Despite yearly increases in the budget earmarked for science, technology, and innovation (STI), only 17.8 percent of the goal was reached.

In addition, according to 2010 figures, in Mexico there was one research and development (R&D) professional per 1 000 members of the active workforce;[3] and 21 percent of all researchers in Mexico were full-time, compared to Brazil's 49 percent in the same year.[4] In 2011, Mexico had 30 graduates from doctoral programs per million inhabitants, that is, 3 691 people, whereby it was trailing Brazil and the United States, with 13 166 and 59 459, respectively.[5] In addition to this, spending per researcher is significantly lower than that of countries with higher STI development. In 2009, for example, the U.S. spent US$236.6 million, while Mexico only spent US$81.11 million and Brazil, US$146.62 million.[6]

Thirty-eight out of every one hundred inhabitants have access to higher education, which is much lower that middle-high- and high-income countries, with their approximately 60 percent. This can be explained by the application of policies that have ensured 99-percent coverage for basic education, 61 percent for high school, and 29.7 percent for higher education.[7] To this should be added that, according to 2008 Organisation for Economic Co-operation and Development (OECD) data, graduates of higher education represent 17.5 percent of all employees in Mexico. This may indicate that a large percentage of graduates work in the informal sector, or, as the study itself mentions, many have emigrated to other countries, particularly the United States.[8] This puts Mexico in eighth place among the countries that expel highly skilled human resources.

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In summary, based on WEF data, Mexico's innovation potential is held back by the low quality of education (100th place), especially in mathematics and science (124th); the scant use of information and communication technologies (81st), companies' limited inclusion of improvements and innovation to better their productivity (75th); and our markets' low levels of efficiency (84th),[9] attributed to the existence of oligopolies, duopolies, and monopolies that impede strong investments in R&D.

The strength of an innovation system comes from the connection between knowledge and production, between university and company. However, according to the same OECD study, in Mexico on average, fewer than two out of every 1 000 workers in companies are researchers; and universities are not seen as an important source of information for innovation.[10]

Finally, one of the most appropriate indicators for registering innovation capability results is the number of patents requested and granted, since it tells us what a country's dynamic is in the generation of new knowledge applicable to economic activities, and gives direct signs of the existing capabilities and their evolution.[11] The Mexican Institute of Industrial Property (IMPI) 2013 report states that it granted 11 485 patents, of which 245 (2.13 percent) were applications from Mexico, putting it in last place among the countries that sought patents on Mexican soil.[12] The country that patented the most inventions was the United States, with 5 612 (48.86 percent), followed by Germany, Switzerland, and Ja-

pan. The same report states that, while it is true that in almost 20 years there has been a favorable evolution in the overall number of patents registered, the number of patent applications by Mexicans has actually dropped.

Many very diverse factors could explain Mexico's position *vis-à-vis* STI. Research points to three important explanations: first, the absence of a long-term, strategic vision that could establish priorities based on the country's most urgent needs, in order to, in turn, determine the routes to be able to concentrate efforts and achieve more compelling results. The second explanation, derived from the previous one, is the lack of coordination and links among the different actors (academia and the public and private sectors), and therefore, the profound dispersion of efforts among federal and state bodies, academia, and private enterprise, which is an obstacle for defining sectoral, regional, and national priorities. The third explanation is the absence of incentives for increasing STI investment, and of mechanisms and financing instruments that could broaden the participation of the different actors, permitting investment of venture capital and including tax breaks for innovation.

Given this disheartening panorama, it is important to mention what different actors interviewed pointed to as the great strengths and opportunities in Mexico. On the one hand, the country has a broad legal and programmatic framework that can foster STI, as well as solid institutions of higher education like the National Autonomous University of Mexico (UNAM) and the National Polytechnic Institute (particularly its Center for Research and Advanced Studies [Cinvestav]), among others. In addition to Conacyt's national and regional networks of research centers, Mexico has extensive capabilities in sectors like biotechnology, genome studies, mechatronics, health, clinical research, chemical engineering, the green economy (biodiversity, environmental protection, renewable energies), and civil engineering, among others. It also has the capability to participate in projects in areas like aeronautics, the automobile industry, advanced manufacturing, renewable energy, the environment, sustainable urbanism, information technologies, nursing, agriculture, food bio-security, and industrial agriculture.

Knowledge has become the driving force for comprehensive human development, productivity, and competitiveness. However, Mexico still has a long way to go to achieve a policy to set the country's priorities.

Today's STI Trends: the Strategic Role of International Cooperation

The emergence of new key actors in the systems of science, technology, and innovation, and based on them, the awareness of the need for new forms of governance in those systems are undoubtedly clear trends internationally. In this context, the government loses its centrality in the definition of scientific policies, while other actors articulated in networks take on an essential role: researchers, institutions of higher learning, research centers, and small and medium-sized firms, among others. All this points to a logic of collaborative relationships in which linking up and joint work among actors is indispensable for generating knowledge and innovation. The alliances among public and private actors, and between academia and companies are today the way forward for overcoming many obstacles.

Work in collaborative networks implies new forms of institutionality and organization that would put an end to the isolation of actors; they would allow them to complement each other in their work, and would permit the development of capabilities and greater agility in implementing programs, projects, and research funds.

The context in which Mexican international STI cooperation policy will develop will be characterized by factors such as an international atmosphere of strong innovation, centered on the most strategic interests of the dominant economies; high investment levels by country and sector, significantly higher than those that Mexico has earmarked in the last decade for science and technology; the very probable widening of gaps in science, technology, and innovation among countries and regions, and therefore, as already mentioned, the growing influence of the use of formal working networks, supported institutionally by governments and companies, to increase competitiveness and innovation capabilities.

In the framework of these trends, international cooperation plays a fundamental role. However, in this sphere also, the vision of the Mexican state has been limited. While in OECD countries this cooperation is a priority, Mexico's 2007-2012 Special Science, Technology, and Innovation Program (Peciti) limits itself to recognizing it solely as a source of financing.

Mexico's innovation potential is held back by the low quality of education, companies' limited inclusion of improvements and innovation to better their productivity, and our markets' low levels of efficiency.

Information from Conacyt and the Mexican Agency for International Cooperation for Development (Amexid) showed that during the 2006-2012 period, Mexico participated in bilateral, multilateral, South-South cooperation, and triangular programs, and, to a lesser extent, formalized projects for decentralized and trans-border cooperation. These programs focused mainly on training human resources (65 percent), scientific research (53 percent), technological development and innovation (24 percent), and infrastructure (2 percent).

In terms of topics, scientific research emphasizes cooperation on environmental issues (22 percent), followed by the food sector and agribusiness and pharmaceuticals and health sciences (18 percent each); ICTs and energy (12 percent each); chemicals and petrochemicals (9 percent); and aeronautics and the automobile sector (8 percent). The main Mexican institutions that have participated in international cooperation programs have been the UNAM and Cinvestav, again revealing the enormous concentration in Central Mexico and in those institutions.

We can conclude that Mexico has participated *reactively* in international cooperation efforts without a defined strategic policy and with very limited resources. How can it move toward a knowledge-based society under these conditions?

Mexico's Great Challenges

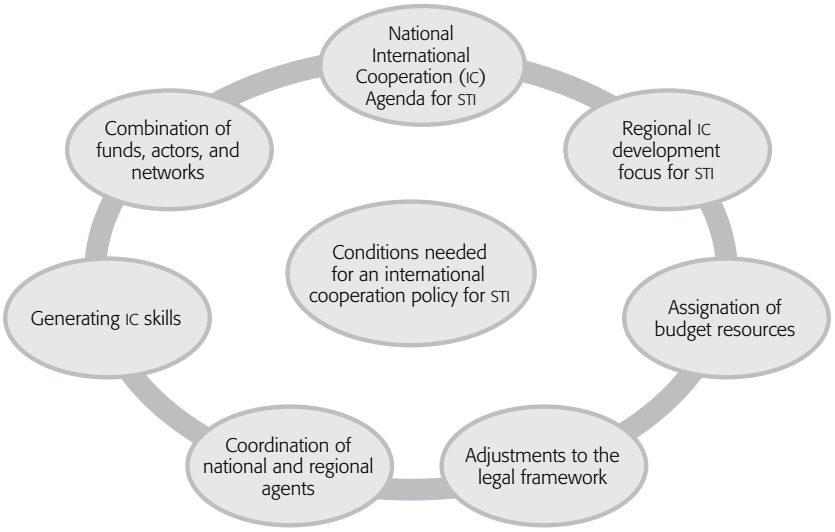
The research results culminate in a series of proposals that can contribute to Mexico positioning itself better regarding STI:

1. *Foster international cooperation*. This must be considered a priority and, therefore, an *ad hoc* policy must be designed with a normative and programmatic framework that promotes it; that fosters activities centered on education and research to strengthen the triangle of knowledge; that encourages the participation of small and medium-sized companies in research-innovation projects; that contributes to the development of a strategic focus for the mobility of students and researchers; and that makes Mexican STI visible, along with their potential and the opportunities they offer, while minimizing the bureaucratization of cooperation processes.
2. *Strengthen the international STI cooperation system*. This means formulating an institutional design and launching an organizational model consistent with the aims of the cooperation policy that will overcome the current dispersion and fragmentation; that will make working in networks a priority; and that will incorporate cooperation as a transversal component of STI. To do this, coordination between Conacyt and Amexid is strategic.
3. *Guarantee the public nature of cooperation policy*. This must be done through substantive procedures and spaces for deliberation, consultation, and decision-making by the scientific community, companies, and organizations of civil society on an ongoing basis.
4. *Ensure the existence of systems for information, follow-up, evaluation, and dissemination* that make it possible to learn from experience, as well as to establish mechanisms of transparency and accountability.

Advancing toward an International STI Cooperation Policy

Lastly, it is necessary to clearly identify the fundamental aim. Here, we refer to the UNAM's proposal: making knowledge and innovation a fundamental lever for Mexico's sustainable economic growth, favoring human development, making greater social justice possible, consolidating democracy and peace, and strengthening national sovereignty.[13] The diagram in the following page illustrates some of the basic conditions needed for this:

1. *National-International Cooperation Agenda for STI.* This would establish the priorities for topics and sectors in accordance with the 2013-2018 National Development Plan, as well as the International Cooperation for Development Program (Procid), and the Special Science, Technology, and Innovation Program (Peciti).
2. *Regional development focus.* This would make it possible to identify and better attend to priorities, needs, and interests, as well as bolster the existing strengths and competences among actors from the different states. The need to regionalize arises from the recognition of the heterogeneity and plurality of Mexico's regions.



3. *Increasing STI investment.* To this end, it is essential to make existing funds, sources, and resources consistent and comprehensive, as well as to consider alternative sources of financing and the promotion of incentives for innovation.
4. *Adjusting the legal framework.* Here, the aim is to harmonize the legislation on science and technology and on international cooperation for development, as well as to bring together a programmatic framework.
5. *Coordinating agents in a field of multiple actors.* This would operate among public and private actors, institutions of higher learning, research and experimentation centers, civil society organizations, and international agencies working in Mexico, among others. It is also necessary to strengthen multi-level governance in the local, state, regional, and national spheres.
6. *Generating the skills needed to implement actions for STI international cooperation.* Here, the idea is to create and strengthen institutional capabilities, understood as an intangible resource that allows actors to perform appropriately to obtain optimum sustainable results in accordance with their interests and needs.[14]

Mexico will move toward a knowledge society and toward a state policy of international cooperation for science and technology to the extent that it fosters these conditions. VM

Notes

[1] The reflections in this article are the result of research carried out by the José María Luis Mora Institute at the request of the National Council for Science and Technology (Conacyt) in the second half of 2012. The research team, coordinated by Gabriela Sánchez Gutiérrez, is comprised of Simone Lucatello, Esther Ponce Adame, Sonia Romero, Bibiana Gómez, Alejandro López Mercado, José de J. Sosa, Gabriela Díaz, María Eugenia Mesta, and Jorge Pérez Pineda. IDOM Consulting participated as a partner research team, made up of César Valle, Álvaro Gutiérrez, Daniela Aguado, and Diego López.

[2] WEF, "The Global Competitiveness Index 2012–2013: Country Profile Highlights," www3.weforum.org/docs/CSI/2012-13/GCR_CountryHighlights_2012-13.pdf.

[3] Red de Indicadores de Ciencia y Tecnología 2010, "Políticas institucionales y prioridades en América Latina e indicadores comparativos," www.ricyt.org.

[4] Organización de Estados Iberoamericanos (OEI), "Ciencia, tecnología e innovación para el desarrollo y la cohesión social. Programa iberoamericano en la década de los bicentenarios," 2012, www.oei.es/documentociencia.pdf.

[5] Conacyt, "Programa Especial de Ciencia y Tecnología 2001-2006," 2001, http://planeacion.cicese.mx/docsvarios/pecyt-indice.htm.

[6] OEI, op. cit., p. 36, based on data from RICYT and the OCDE.

[7] Ibid., p. 37.

[8] Organisation for Economic Co-operation and Development (OECD), "Science, Technology and Industry Scoreboard 2007, Briefing Note on Mexico" (Paris: OECD, 2008).

[9] Klaus Schwab, "The Global Competitiveness Report 2011-2012," WEF, p. 514.

[10] Judith Sutz, "Relaciones universidad-empresa en América Latina," in Jesús Sebastián, *Claves del desarrollo científico y tecnológico de América Latina* (Madrid: Fundación Carolina/Siglo XXI, 2007).

[11] Gustavo Lugones, Patricia Gutti, and Néstor Le Clech, *Indicadores de capacidades tecnológicas en América Latina* (Mexico City: CEPAL, 2007), p. 45.

[12] Secretaría de Economía, Instituto Mexicano de la Propiedad Industrial (IMPI), "IMPI en cifras 2013," January-March 2013 (Mexico City), http://www.impi.gob.mx/wb/IMPI/impi_en_cifras2.

[13] UNAM, "Hacia una agenda nacional en ciencia, tecnología e innovación," Mexico City, September 2012, www.foroconsultivo.org.mx/documentos/agenda_nal_cti_extenso_260912.pdf.

[14] Eduardo Ballón, Jorge Rodríguez, and Molvina Zeballos, *Fortalecimiento de capacidades para el DTR: innovaciones institucionales en gobernanza* (Santiago de Chile: Centro Latinoamericano para el Desarrollo Rural, 2009), p. 62.