

# EFFECTIVE INDICATORS FOR SCIENCE INTERNATIONALIZATION

Indicadores efetivos da internacionalização da ciência

JOSÉ RENAN DA CUNHA-MELO

## ABSTRACT

**Objective:** To review of concepts and actions that aim to analyze the effects of internationalization of science and education, with emphasis in the medical field and its basement in development policies adopted by nations, exploring the potential for international interdisciplinary cooperation of each laboratory, department, university or institute. **Method:** Search of indicators to assess the degree of internationalization of universities and research institutes in several interconnected levels: organizational, regional, sectoral and global, and policy-making in science, technology innovation and higher education. **Result:** Scientific research is still carried out individually, but is now much more closely integrated with other social processes. The scientist is no longer a stranger who is allowed to surrender to his hobby to do what it wants. Internationalization of research and medical education, although it is among the topics of greatest need, as the globalized world, is difficult activity to be assessed. The leaders seem to have understood that the knowledge societies, leading to economic policy based on knowledge, can result in economic and social progress of nations. This fact has motivated increasingly the incentive to actions aimed at addressing global problems (eg health, climate change) by funding research that generates new knowledge. **Conclusion:** The consensus is that the internationalization of science is desirable and necessary for the sustainable development of nations. However it cannot be done only by encouraging and promoting the outward students and researchers abroad. It is necessary, in addition, offer conditions to foreign researchers and students teachers to work in collaboration with Brazilian and raise the country to international scientific standards.

**Key Words:** Education, higher. International cooperation. Quality indicators, health care. Education, graduate.

## INTRODUCTION

Scientific research generates new knowledge which can act as the central axis of development and prosperity contributing to the solution of significant social problems. The country introduction to international scientific standards requires a set of changes, including access by students to online global scientific content and the change of attitude of scientists. This is not just sending students and researchers abroad. It is advisable to raise the country to international scientific standards and to internalize the internationalization, absorbing the lessons from advanced countries in order to overcome specific demands of the country. Looking into the country could be one of the ways leading to of internationalization of science, as well as a way to detect the huge Brazilian asymmetries of scientific and technological development waiting for solutions.

The Science Without Borders program is an example of Brazilian policy of internationalization. Due to the global economic crisis the governmental financial support for Brazilian students abroad constitutes a business advantage for the host countries. The cost of this program is high and there is a fear that the money expended on it could compromise the internationalization of national research.

If science is universal no scientific boundaries among nations should exist. This might be the basis by which medical schools are directing the international approach towards teachers and students mobility as well as curricular innovation grounded on scientific sharing between two or more countries.

Some schools (Netherlands, UK and Sweden) adopted international health discipline in their curricula. However, internationalization is more than medical knowledge or specific international medical curriculum. Teaching and learning medicine, within the overall context, opens possibilities for students and teachers to practice medicine in another country and to learn from the international community. In addition, internationalization is more than providing undergraduate international experience. It also requires exchanges in cutting-edge research.

## METHOD

Search for indicators capable of measuring the degree of

internationalization of universities and research institutes in several interconnected levels: organizational, regional, sectoral and global and policy-making science, technology innovation and higher education.

## RESULTS

### Internalize to facilitate the internationalization

Despite the recognized importance of internationalization as an effective policy of economic and cultural development, analysis of the internal problems of each country is a cornerstone of this process.

With illustrative purposes it is described the Denmark experience. In that country, the Ministry of Science, Innovation and Higher Education Research published the 2020 catalog: Strategic Research Horizons<sup>1</sup> for which broad partner universe - universities, research councils, ministries, industry and interested organizations, among others - identified strategic promising and essential research areas for the country. Five areas have been selected in this context:

1. Green economy - A vision of a society with a green economy where technological and knowledge-based solutions to great global challenges related to natural resources, environment, energy, climate, and food are used to drive Danish growth and employment, and to protect nature and the environment.
2. Health and quality of life - A vision of a society with health and quality of life, where individualised treatment of diseases and a cost-effective health care and care sector will improve quality of life and a high life expectancy, along with export and prosperity.
3. High tech society with innovation capacity- A vision of a high-tech society with innovation capacity where strategic growth technologies, digital solutions and new production systems will strengthen productivity and create the basis for new, technologically-based solutions to great societal challenges.
4. An efficient and competitive society - A vision of an efficient and competitive society where an intelligent organisation of society will prevent disease and social problems, strengthen labour market affiliation, productivity development and competitiveness, and where fitting physical framework and transport systems will reduce pollution and congestion.
5. Cohesive and competent society - A vision of a competent, cohesive society where the population has a high level of education and competence which

will meet the needs of the individual and society, and where knowledge, cultural understanding and cross-cultural competences will prepare Denmark for the global competition.

This proposal creates firm basis for prioritizing the development of strategic research and to assess their social result. In this context, it is easier to find indicators for the evaluation of internationalization.

A critical analysis to find indicators for the concept of internationalization some points are important<sup>2</sup>:

1. Recognition of the importance of research for the study of global challenges and for investment in this research support programs.
2. Diplomacy of science to identify global challenges focused on people. This aspect of people influences the scientific diplomacy, increasing the presence of science and technology in the diplomatic world, especially in the Ministry of Foreign Affairs of the State Department.
3. Science has an important role in public policy to be able to supply objective data that are necessary for development of international politics. This is framed in multilateral negotiations that also depend on reliable scientific data.

Intergovernmental Panel on Climate Change - IPCC is an example of the interface between science and policy. This panel, composed of scientists and government officials, has worked for more than 25 years to make science concerning climate changes accessible to the public and the political class, promoting discussion on biodiversity, ecosystem and the relationship between the two.

Communication is at the core of diplomacy and, gradually, in the center of science, by its extramural laboratories and universities expansion, reaffirming the importance of interaction between disciplines, sectors, institutions, professions and nations.

True internationalization should seek the following objectives<sup>3</sup>:

1. To enlarge the territorial and ethnic approaches.
2. To provide research data and theories beyond national borders, to test its consistency and validity.
3. To investigate the national variances to help raise awareness and identify limiting factors and theory limits.

The production of transnational and cross-cultural knowledge, with common dissemination of results is the best way to understand the values of interaction with overcoming nationalist and nativist approaches domain and confrontation. True internationalization, desirable and necessary, is not just rationalization and strengthening of existing bridges and traditional networks, but also bilateral participation of scientists from diverse backgrounds and qualitative aspects more than quantitative new strategies for international calls to prevent the marginalization and expand the niches talent.

The universal validity of the data and theories cannot be owned by an individual or group. The inclusion of experience and diverse points of view as it becomes imperative prerequisite for valid scientific theories. Universities use various strategies to internationalize, but with limited activities to educational exchange of students and teachers. Few include in its academic mission, strategies for internationalization of research.

Modern policies are described as knowledge societies or knowledge-based economy. The political choice has a major impact in the way knowledge is produced, disseminated and used. With the financial crisis, the knowledge policy has been accepted as the road to growth and as a solution instrument

#### Postgraduate as internationalization agent

The internationalization of Brazilian postgraduate occurred due to individual prestige of teachers, contacts with foreign researchers in internship programs, doctorate or post-doctorate

abroad, and informal contacts between researchers in scientific meetings. The foreign researchers showed interest in participating in cooperative work only when the object of research of interest did not exist in their country of origin. The areas of infectious and tropical diseases or biodiversity of the Amazon forest exemplify this situation.

In the past international collaboration occurred almost always of biological material transfer to outside groups. The foreign groups have processed the materials, obtaining and publishing the data and sharing the Brazilian contributor's name as co-author, which constituted kind of payment for the material disposed.

Globalization and the emergence of international organizations aimed at the implementation of collaborations between countries changed the scenario, and today the internationalization of scientific research became a priority on the agenda of governments as a way to enable the scientific/technological advancement of countries. The knowledge in nations economic policy boosted orders to internationalize science in benefit of citizens. Internationalization thus concerns the integration of global perspectives and intercultural dimension in teaching/learning, research and services related to higher education.

The General Secretary of the European Medical Education Association (AMEE), Ronald Harden said that the future of internationalization implies transnational initiatives for medical schools to work with international institutions to achieve common goals at key points of the society.

The actions, which were individually done before, have been taken by development agencies, universities and research institutes through formal agreement between parties. At the same time, technological advances enabled the creation of networks of cooperation in research, allowing the efforts of many researchers for global problem solving issues related to climate and understanding of the mechanisms, prevention and treatment of disease<sup>4</sup>.

Many current universities develop strategies for internationalization. But teachers and/or researchers adhere only slightly to them<sup>5</sup>. They need to be aware of the consequences of their decisions and actions, in addition to their classrooms and laboratories, their schools, their workplaces and their country.

The tendency to plan science routes, in line with the overall need of the problems afflicting the planet, began more than 50 years ago. The European Science Foundation (ESF), founded in 1974, is an independent, non-governmental, whose members are 72 national funding agencies, research agencies and academies from 30 countries. The ESF has brought together organizations dedicated to all branches of science, to create international cooperation platform for scientific research and development of science and research policy in Europe.<sup>6</sup>

Another initiative was the creation of the European Research Area (ERA), which in agreement with the EU member countries, can establish protocols and indicators in order to monitor and evaluate the process of research policy coordination and the EU and its member states development. The Communications Commission, created to draw up a report on the activities of ERA, redefine priorities and provide concrete actions to be taken by member countries through its universities, research institutes and funding organizations<sup>7</sup>. Germany, a member of the ERA, is a leader in science and technology between EU countries. In 2011 Germany spent 75.5 billion euros in this area. Research institutions include non-academic universities and institutions of comparable importance to universities. The non-university institutions include the country's largest organizations: Max Planck Society, Fraunhofer- Gesellschaft, Helmholtz Association of German Research Centres and Leibniz Association<sup>8</sup>. In 2011, the German industry received 67.7% of spending on research and development. Consequently, one in two companies is active in innovation. This strategy to encourage high-tech, adopted since 2006, aims to connect the most important scientists in S&T in the country and strengthen the power of German innovation. The strategy "high tech" ERA is focused in five priorities<sup>9</sup>: climate/

energy; health/nutrition; mobility; security; and communication.

Alliances are research and innovation policy. Cooperation industry/ science directed specific application area in the emerging market. In cooperation with the Ministry of Education and Research, sectors of science and industry established in 2012, 11 alliances for innovation. These industry alliances apply five euros for every euro applied by the Federal Government.

The priority fields in ERA internationalization strategy, taking Germany as reference are: to strengthen cooperation with the very best in the world; develop international innovation potential; strengthen cooperation in education and R&D to developing countries; and assuming international responsibility and work to address global challenges.

The initiatives described as strategic: "high tech" pact for research and innovation, higher education pact, an initiative for excellence and internationalization, are designed to complement and reinforce the effects of individual initiatives. The internationalization strategy is in accordance with the directions of the ERA, especially with the Transnational Cooperation and Competition priorities and opening the labor market to foreigners.

The international innovation potential is concerned with issues related to data sharing and the protection of intellectual property, in connection with the objectives of enhancing the scientific knowledge transfer between public and private<sup>10</sup>.

Germany, with the goal of internationalization in higher education, as a key area of international cooperation, is looking for university strategies. To strengthen this policy the Initiative for Excellence program was created. The IE allocated 2.7 billion euros to support the 43 groups of excellence, and 11 strategic institutions in a total of 39 universities and more than 6,000 researchers (25% of which foreigners). The first phase included three fundamental points<sup>11</sup>: graduate schools - structured for training young researchers in high-level research environment; excellence groups - internationally recognized centers of excellence, focusing on thematic research; and international strategies - overall innovation strategy development in universities.

#### Programming research pact for society

The basic principles of international processes include evaluation of promoting scientific research adhered to the principles of excellence, objectivity, transparency, truth and ethics, projects and review articles, candidates to regular teacher and scientists, and institutional assessment. The fundamental basis of this project is best practice in Europe and served as a model for the European Research Council (ERC).

The assessment of the German system of science is international, with participation of researchers from European and non-European (80% of the members of the advisory committees of the Max Planck Society are not German).

Another example that science cannot be individually owned by groups of scientists is the policy adopted by Denmark to define the funding priorities of research<sup>1</sup>. Among the major challenges that can have solutions based on knowledge mentioning the growth of the world population demand for greater prosperity, for energy sources consumption, organic production, climate, environment and natural resources and the extension of life with quality. Longevity brings new demands and new challenges. The development increases the overall demand for technology solutions for health and wellness that can form the basis for better treatment and care. This can result in rational use of natural resources, efficient management of mobility of people and products, reduced pollution, and improve in education, safety and housing; these are global problems.

Internationalization is strategic for institutional research and considered highly relevant to the ERA. Nevertheless, the assessment of the internationalization of research institutions has not received due attention of the control mechanisms. Patient safety, their new rights, new demands and new expectations create the challenge and the need to standardize and make accreditation of medical schools. This may require assessment of the international curriculum system as a result of cooperation

between medical schools.

#### What are medical schools doing to promote the internationalization?

According to ERA, transnational medical education should be governed by European standards and quality assurance protocols. Without this assurance there can be no internationalization. In Europe AMEE, with members in over 90 countries and on five continents, is implementing several initiatives to internationalize<sup>12-15</sup>. Among these can be mentioned the organization of annual conferences and the publication of Journal of International Medical Education, to encourage partnerships and joint projects. A permanent forum on the web (MedEdWorld) is available. On that site, students, teachers, researchers and other partners involved in medical education can discuss and share their ideas both in open and closed groups and can, wherever they live, take part in "webinars" for teachers, and teaching classes for students, guided by an instructor. Thus, medical schools should incorporate the transnational dimension in their mission. On the other hand, in addition to mobility opportunities offered to students and teachers, internationalization should begin at home. This involves having medical schools with broad and critical view, open to global perspectives, filtering the adopting relevant changes according to their cultures, strengths and weaknesses<sup>16</sup>.

Universities that do research undergo to the transition moment of the emerging global model, but have in common, some characteristics:<sup>17</sup> mission; focus on research; new rules for teachers; diversified development; global recruitment; increased complexity; new interrelation with the government and with industry; global collaboration with similar institutions.

#### International knowledge production by poor countries and Regions

Despite the recognition and acceptance of internationalization, as necessary and indispensable today, several problems concerning this action can be raised. Substantial differences among regions of the world are ignored, as well as the frozen or open conflicts between political powers, such as states, or profound asymmetries between participants in the process. Power relations and domination or individual interests - guided relations, exert important influences. Therefore, the internationalization of science suffers political influences that may interfere with several questions concerning the nature and function, its modalities and objectives, and its actors<sup>18</sup>. To reach the state of true internationalization a combination of efficiency, loyalty, justice, equity and productivity should exist. Considering the international scientific scenario three participants can be identified: the core of scientific literature that have the scientific power; the core of the semi-peripheral that has some scientific power; and peripheral participants. This stratification is related to the position of nations in economic, financial and political world. The international scientific periphery represented by the poor countries is in this respect dependent on the central and semi-peripheral cores and has to rely on the development of these nuclei, besides depending on schedules, methods and even scientific objectives. Those countries struggle to exist and to be accepted as partners in knowledge production. Scientists from poor countries need a lot of energy to convince the political authorities on the need to develop scientific research as a way to find solutions for serious social, health and economy problems<sup>19</sup>. They must also convince funding agencies, located in the core and semi-periphery, on the need to develop institutional research in their own countries. Local and international partners should allow them to develop their own planning and research goals. Most of the time it is not possible for them to integrate existing research networks and, therefore, they are not recognized as junior partners or as actual participants in the international production of knowledge. For these participants, true international collaboration does not exist and must be sought. In the World Science Conference organized by UNESCO in Budapest (1999) the existence of structural barriers, resulting

in disparities and marginalization both nationally and internationally, for some regions and social groups, was recognized as well as the urgent need to reduce the gap between developed and developing countries, by increasing their scientific capacity and infrastructure. Therefore, the internationalization of science is desirable and necessary, but not only means streamlining and strengthening existing cooperation. New strategies should be created to avoid marginalization and to increase the number of talents and release the scientific production from nationalist bias and ethnocentric lock<sup>20</sup>.

#### Internationalization indicators

The Forum of the European Science Foundation (ESF) on internationalization proposed 17 indicators (eight for funding agencies and nine for organizations that do research) for evaluation of actions and internationalization processes.

Two categories were designated to allow each organization to define how and why the inclusion and international activity should be effective. Indicators for both categories were divided into three groups: seven mature indicators, seven indicators under development and three indicators "blue sky".

The indicators of mature category require the development of protocols for collection and analysis of data, to evaluate their quality and comparability. The seven indicators in the category "developing" are conceptual basis, but require traditional data collection to confirm the feasibility and comparability of indicators. The three blue sky indicators designed to evaluate specific aspects of internationalization, have yet to be conceptually developed to be found relevant measure connected to the reality observed. With these indicators it is possible to evaluate the internationalization of development agencies and research institutions through activities they develop<sup>21</sup>.

From the point of view of institutional research internationalization can also be represented by the impact of three main processes: promoting flow to/from international agencies; collaboration and standard networks between non-national institutions, groups and individuals; and international co-production of knowledge (publications and technology products)

#### Indicators to assess the internationalization of development agencies

The activities of development agencies are defined in columns. The first defines the flow of reserves related to international development, or bilateral development agency, three columns describe the international orientation of the different funding schemes: production of knowledge dissemination and circulation of new knowledge and collaboration and research networks. The fifth column is related to the governance and processes of agency internationalization<sup>21,22</sup> (Figure 1).

#### Indicators for measurement of institutional research (Research Performing Organisations (RPOs))

RPOs are today more and more concerned with the expansion of its internationalization. Its objectives are related to opening of its research agenda for global interest issues or access to different funding sources.<sup>23,24</sup> They seek also to increase the quality and visibility of its research activity. These organizations have experience in reporting to government agencies and in the evaluation of research organizations and university.<sup>6,8</sup>

The first indicator is related to the development of flow coming from other countries. The second evaluates access to publications with acknowledgements to the promotion of foreign agencies. For the production of knowledge, the number of publications co-authored with collaboration of members of the international research community is a good internationalization index. The movement of knowledge is another valuable index of research internationalization. It can be gauged on the basis of various activities: recruitment of researchers, bilateral mobility and mutual visits. The indicators for evaluation of collaboration and participation in networks are more difficult to be created. The assessment is facilitated by actions of institutions who do research and have important role in the internationalization of the national research system. Another important indicator is assessing the infrastructure that enables the use of the facilities by researchers from other countries. The number of researchers using the infrastructure is a good internationalization evaluation index (Figure 2).

Beyond these two indicators charts to assess the internationalization, we can add two more for the Brazilian case for students and research internationalization<sup>25,26</sup> (Figures 3 and 4).

## DISCUSSION

This paper intend to present a review of the concepts and actions that aim to analyze the effects of internationalization of science and education, with emphasis in the medical field and its basement in development policies adopted by nations.

Diplomacy of science became popular term to cover the various roles of science in foreign policy, with the possibility of building partnerships between countries, regardless the political winds. Despite the enormous regional differences with regard to culture and ethnicity, the most advanced organizations and companies have proposed the use of multiple indicators to assess the outcome of the policy based on knowledge built through internationalization.

## CONCLUSIONS

The consensus is that the internationalization of science is desirable and necessary for the sustainable development of nations. However, it cannot be done only by encouraging and promoting the outward students and researchers abroad. It is necessary, in addition, to offer conditions for foreign researchers students and teachers to work in collaboration with Brazilians and raise the country to international scientific standards. In

INDICATOR	INDICATOR NAME	ORIGIN	TYPE
1	Budget for research programs in collaboration	Data within budget allocation	Mature
2	International co-authoring articles	Database of international field thanks to AF publications	Development
3	International patent co-authoring	Bank international data (patents and articles)	Blue sky
4	Budget for attracting foreign researchers	Internal allocation bank of budget data. Annual report	Mature
5	International mobility	Internal database. Annual report. Available, but depends on the report quality	Development
6	Co-funding the search result	Bank of international publishing data using the field thanks to AF	Development
7	Evaluation procedure	Internal database annual report	Mature
8	Opening programs	1. Internal data allocation budget 2. Internal selection of submitted processes 3. Data of international bank publications using the field thanks to AF	Blue sky

FIGURE 1 – Chart with indicators to assess the internationalization of development agencies (AF)

INDICATOR	INDICATOR NAME	ORIGIN	TYPE
1	Budget coming from other countries	Internal data	Mature
2	Budget coming from other countries: generating results	Database of international publications and thanks to funders	Development
3	International co-authors in international publications	International database	Mature
4	Recruitment of researchers from other countries	Internal database. Annual report	Mature
5	International mobility	Internal database. Annual report.	Development
6	Budget for programs or research projects in collaboration	Posing total cost versus hard marginal cost	Development
7	International use of own infrastructure	For each type of infrastructure, relevant measure of the use by foreign researchers must be set	Blue sky
8	Recruitment international committees	External local member does not account. Rules should limit number of external members. Data must be confidential	Development
9	Evaluation procedure	Numbers depend on the rated entity (whole institution, research departments, groups, individuals)	Mature

**FIGURE 2 - Indicators for evaluation of organizations that conduct research (RPO)**

1. Training of young researchers within international standards
2. Development programs with national, regional and international focus best coordinated and aligned with complementary situations.
3. Cooperation instruments for development and scientific and technological cooperation strategically aligned and supplemented, when possible, within the priorities agreed between the participating countries
4. Federal Government should use its influence in international organizations to develop and implement "International Research Agenda", giving priority to global challenges such as climate change, natural resources, health and safety
5. Implement the presence of Brazilian science in other countries; provide information to the industry; collect data related to strategies in science and innovation; promotion goals in higher education, research and innovation in Brazil.

**FIGURE 3 - Internationalization indicators for assessment of government policy**

other words, we must "internalize the internationalization", absorbing the lessons provided by foreign countries and learning to overcome the specific demands of our needs. The look into the country is a mean to internationalize science. It allows the perception of the huge asymmetries of the scientific and technological development in Brazil. The internationalization of science is essential today and points to the need for development, implementation, and improvement of effective indicators of evaluation.

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1. Verification of the acquisition of specialized knowledge
2. Survey on the acquisition of social skills (communication, presentation)
3. Measurement of critical reason in problem solving development
4. Measurement of thought in depth and from different angles and perspectives
5. Measuring the PhD title provides individual difference in the workplace
6. Access to professional networks and building personal relationships
7. Professional and ethical recognition by society

**FIGURE 4 - Internationalization indicators for the researcher and student**

## RESUMO

**Objetivo:** Apresentar revisão dos conceitos e ações que objetivam analisar os efeitos da internacionalização da ciência e da educação, com ênfase na área médica e seu embasamento nas políticas de desenvolvimento adotadas pelas nações, explorando o potencial para cooperação internacional interdisciplinar de cada laboratório, departamento, universidade ou instituto. **Método:** Procura de indicadores que possam avaliar o grau de internacionalização das universidades e institutos de pesquisa em vários níveis interconectados: organizacional, regional, setorial e global e para definição de políticas nas áreas de ciência, tecnologia inovação e educação superior. **Resultado:** A pesquisa científica ainda é realizada individualmente, mas está atualmente muito mais intimamente integrada a outros processos sociais. O cientista não é mais um estranho que tem permissão para entregar-se ao seu passatempo de fazer aquilo que bem entende. Internacionalização da pesquisa e da educação médica, embora esteja entre os tópicos de maior reconhecimento como sendo necessidade do mundo globalizado, é atividade difícil de ser avaliada. Os governantes parecem ter entendido que as sociedades do conhecimento, induzindo a política econômica baseada no conhecimento pode resultar em progresso econômico e social das nações. Esse fato tem motivado de forma crescente o incentivo às ações que visam a abordagem de problemas globais (e.g. saúde, mudanças climáticas) pelo financiamento da pesquisa que gera conhecimento novo. **Conclusão:** É consenso que a internacionalização da ciência é desejável e necessária para o desenvolvimento sustentável das nações. Entretanto ela não pode ser feita somente incentivando e fomentando a ida de estudantes e pesquisadores para o exterior. É preciso, em adição, oferecer condições a professores pesquisadores e estudantes estrangeiros para que possam atuar em colaboração com os brasileiros e elevar o país aos padrões científicos internacionais.

**Descritores:** Educação superior. Cooperação internacional. Indicadores de qualidade em assistência à saúde. Educação de pós-graduação.

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Address for correspondence:

José Renan da Cunha-Melo

[jrcmelo@medicina.ufmg.br](mailto:jrcmelo@medicina.ufmg.br)