Scientific production in Mexican universities: Rates and expectations toward competitiveness

Javier Tarango

Juan D. Machin-Mastromatteo

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Abstract

This article analyzes emerging issues that Mexican universities are experiencing with scientific production processes, their impact on assessment indicators that determine their level of competitiveness, and the identification of assessment dimensions and criteria related to the activities of professors and researchers. Examples of previous research on universities' competitiveness are offered to provide suggestions for recognizing the need for legitimized models that allow assessing scientific production in Mexican universities.

Keywords: scientific production; scientific communication; institutional competitiveness; universities, Mexico

Introduction

Countries with peripheral economies, such as Mexico, have specific requirements for their development and competitiveness. For instance, they may experience dependency with a variety of factors, such as primary products and sometimes technology. This dependency extends to every other area that develops unilaterally; as such, there has been dependency in terms of knowledge creation and publication in scientific journals. Over the last few years, Mexican universities have promoted actions to generate social capital in universities (mainly public) by means of their professors and researchers. Some such actions are: requiring teachers to obtain doctorate degrees to strengthen their qualifications; favoring collegiate work among academics over individual efforts; and developing research initiatives and products which can be assessed at an individual and institutional level by means of scientific communication processes.

Results observed in the past 15 years or so have been meaningful, although not sufficient or balanced throughout the country; and results are uneven among the different types of higher education institutions (HEIs). Various HEIs were created to fulfill different political purposes, often in consonance with the national policies and legislations that were in effect when they were established, which aimed to overcome certain national needs, and that were usually of a social nature. This document aims to analyze the need to assess the competitiveness of HEIs in terms of their scientific production, and to draw attention to the imprecise definitions of measurement criteria that have been used in specific situations. Culturally, Mexico has displayed inconsistencies in government planning, hence the need to seek uniformity and standardization in various areas, for example, pensions and retirement; a common curricula for high school education, for which there are over a hundred proposals; and the processes of educational reforms and the development of suitable teacher evaluation methods for their recruitment and permanence in the basic education system. These areas have undergone complex developments leading to uncertainty, confusion and general instability, which will probably last until their processes are

standardized. There have been attempts to standardize criteria for measuring scientific production, such as the National System of Researchers (NSR), part of the National Council for Science and Technology (Consejo Nacional de Ciencia y Tecnología, 2012), which is the most welcomed nationwide. The inclusion of professors and researchers from Mexican universities in the NSR has not been complicated, perhaps because professors generally have a high cultural level and acknowledge the importance of such initiatives. Moreover, they are financially motivated to join the NSR, thus increasing their income, and therefore universities' budgets can also benefit from the NSR.

Identification of indicators for scientific production assessment

The scientific products that Mexican professors and researchers develop and publish or disseminate through formal media are articles, books, book chapters, and dissertations (Campos, 2000; Muñoz-Muñoz, 2006; Romanos, 2009). However, challenges emerge when the assessment of scientific production, at both individual and institutional level, considers the quality of intellectual production instead of just the quantity (Ferreira, Malerbo y Silva, 2003), and when circumstances require that assessment processes take place on a constant and systematic basis. Hence, professors should generate knowledge as a regular activity, not casually (Shults, 2005).

University professors were originally hired to exercise teaching and not so much for researching, so Mexico needs to strengthen teachers' research competencies (Modrego, 2002; Gorbea, 2010). Teachers must be prepared to face research challenges by identifying their potential and define their current conditions and opportunities for growth. To accomplish this, Mexican universities need a clear idea of research-related priorities. According to Manjarin et al. (2009), it is very common for faculty members to participate in relatively easy activities such as conference presentations, and less common for them to participate in more substantial ones, such as writing and publishing scientific papers – something they consider to be more complicated. Nevertheless, this latter activity has become a priority for institutional assessment.

Scientific production assessment must consider intellectual products and scientific communication environments, and be consonant with the national benchmarks suggested as indicators by the National Autonomous University of Mexico (UNAM, 2012). Table 1 shows a ranking system developed by the scientific observatory *Comparative Study of Mexican Universities*, which includes dimensions and scientific production measurement criteria (Hernández-Gutiérrez, 2015; Tarango, Hernández-Gutiérrez y Vázquez-Guzmán, 2015).

Overview of the scientific production in Mexican universities

The Mexican higher education system has approximately 2800 universities that, for scientific production measurement purposes, can be divided in nine types: federal public universities (3), state universities (33), federal institutes of technology (118), state institutes of technology (117), technological universities (62), polytechnic universities (28), intercultural universities (11), private universities (1,838), and other public universities (23). The numbers of students and professors vary significantly among these types of institution.

Scientific production assessment criteria are intended to identify competitiveness and are used to evaluate all university types. However, the same criteria may not be applicable to all university types, because the origin of each type is different. Mendoza (2009) indicates that we should considering their historical context, target population, academic models, strategic objectives, and the roles of their teachers. The origins of the different types of university may be summarized as follows:

a) Federal public universities were created from 1551 to 1978; they served as a foundation for other types of university.

b) State universities aimed to equally distribute knowledge in society.

c) Federal and state institutes of technology attempt to provide equality of educational opportunities while supporting industrialized regions.

d) Technological universities include decentralized educational services, emphasis on the local labor market, and support emerging economies.

e) Polytechnic universities, other public universities and Intercultural universities are aimed to other populations, such as indigenous people; they do not have uniform goals.

f) Private universities may have managerial, religious, specialized, technical and/or traditionalist orientations.

Table 1. Matrix of dimensions and measurement criteria for scientific production

Dimensions	Criteria
Knowledge creation processes	Publication of articles in indexed and refereed journals (Web of Science and SCOPUS), and popular science articles
Educational qualities of faculty members	Professors and researchers with doctoral degrees, their recognition as national researchers and certification of their teaching activities.
Scientific production impact	Number of articles as first author, citations, and institutional, inter-institutional and regional collaborations.
Ability to innovate	Patents (requested and registered)
Scope of professional practice	Interest in collegiate work, status of recruitment (part time, full time), quality standards and certification of school curriculum.
Institutional capacity for managing of scientific publications	Scientific journals developed by universities

Hernández-Gutiérrez (2015) analyzed the scientific production behavior in the different types of universities, and found that, while all the seven types listed above showed early stages of scientific production, not all of them were entirely suitable for the generation of knowledge, partly because of the original purposes for their creation, which do not usually consider research a priority, and from the limited number of years since their establishment. The study highlighted the importance of the federal public universities and state universities, the two types with most of the research contributions in the country. The contributions from federal public and state universities are vital for the total national scientific production. Thus, it is relevant to consider their strengths and weaknesses; and the assessment of their scientific production levels is necessary to obtain benefits from the State, such as financial support, for both professors and their institutions. Table 2 shows a brief comparison of the scientific production of federal public and state universities.

This situation leads us to seek ways to motivate those universities that are not so active in research to add research assessment criteria to their academic and scientific activities. The concept of the Relative Productivity Index (RPI) has been introduced in Mexico with the aim of achieving a more equitable comparison between different types of university. The RPI compares scientific production levels among the members of a group of homogenous institutions by identifying the best and most unfavorable results as well as the arithmetic mean. It ranks specific institutions in terms of their needs for increasing scientific production, by comparing their scores either with the arithmetic mean of the group or with the best scores achieved by members of the group (Tarango, Hernández-Gutiérrez y Vázquez-Guzmán, 2015; Hernández-Gutiérrez, 2015). Hernández-Gutiérrez (2015) conducted a detailed analysis on the RPI of state universities in Mexico, and identified the following relevant findings:

a) Identification of few assessment criteria that impacted meaningfully on their research behavior, namely: publication of indexed articles, certification of professors to ensure academic quality, regional and institutional levels of collaboration, number of approved patents, collegiate work, development of scientific journals, and school population growth.
b) Most (63.63%) state universities are below the arithmetic mean of the group.
c) The universities that produce more research activities show high variability in longitudinal results (e.g. 5 years), while those producing less tend to remain passive.

Table 2. Comparison between federal public and state universities

Federal Public Universities	State Universities
Highly regarded and internationally recognized institutions such as UNAM, National Polytechnic Institute, Colegio de Mexico; which are located in the capital of the country	Commonly referred to as autonomous, located along México's states, with the exception of the capital. Renowned for their size and academic quality. Examples: University of Guadalajara, Autonomous University of Nuevo Leon, and the Meritorious Autonomous University of Puebla
Socially renowned HEI regarding activities of scientific production	The second type of university with the best indicators for scientific production
High scientific production of peer reviewed and indexed articles	Medium scientific production of peer reviewed and indexed articles
Creation capability of own scientific magazines	Creation of peer reviewed journals (though not of great impact)
Considerable amount of professors who are renowned national researchers by diverse national evaluation commissions	Professors who are renowned as national researchers, with sufficient qualifications for teaching
High number of accredited undergraduate and graduate academic programs	High number of accredited undergraduate and graduate academic programs
Active participation in the registration of patents (requested as well as granted)	Moderate participation in the registration of patents (mostly requested)

López-Carrasco (2013) studied scientific-technological competitiveness by comparing the behavior of state universities from each state of Mexico resulting a theoretical model, simplified as a linear function and grouping assessment criteria in three areas: productivity, quality, and innovation. The following formula was proposed:

Scientific-technological competitiveness = assessment factors (productivity + quality + innovation)

This theoretical model derived from the concept of organizational competitiveness, which states that competitiveness throughout an entity (an organization or a data set) is based on productivity, quality, and innovation (Palacios and Vargas, 2009). López-Carrasco (2013) also evaluated scientific production data and analyzed the level of scientific production and the average socio-economic level of each Mexican state, using the yearly results of the Mexican Institute for Competitiveness (Instituto Mexicano para la Competitividad, 2012). Findings are pertinent for both universities and states; they showed that many states show low levels of scientific production, there is no clear cost-benefit correlation between funds allocated to research, scientific production levels and the population, and the correlation between the research production of Mexican states and their economic status is complex. The Mexican states with the most competitive universities regarding scientific production are not necessarily those with the best socioeconomic conditions. States that are closer to the capital have a large amount of public universities. Northern states have higher levels of socioeconomic development through their industries, and higher education seeks to develop human resources that can manage their productive sectors. Southern states have low socioeconomic conditions, but are characterized by large numbers of higher education institutions. If universities were to enhance their competitiveness, they might have an impact on socioeconomic levels, by providing innovation to industry and conducting research that can help improve conditions for the people.

Conclusion

There have been a number of relevant studies and findings on the assessment of scientific production in Mexican universities. Although there is consonance among their results, each aimed at analyzing a particular situation to support decision-making. However, there is a pressing need to establish standardized research indicators that are generally accepted and used by all stakeholders, in order to push this area further.

Social, economic, and especially cultural circumstances in Mexico gave rise to several official standards, such as those from the Consejo Nacional de Ciencia y Tecnología (2012), which were proposed by a variety of government institutions working in isolation, in attempts to systematically evaluate scientific competitiveness in universities. The country's development requires evaluating the performance of professors and researchers working at Mexican universities, raising awareness on the importance of research and promoting the ways in which scientific production and communication is undertaken and how it is assessed.

Developing Latin America

The role of university professors in Mexico, which has been traditionally centered on teaching, is being redirected and is now starting to be centered on research and scientific communication. The processes of adaptation might take a long time, given that we should raise research awareness, interest, willingness and competences as a starting point. These elements may not be so easily combined but can allow us to achieve scientific production growth and optimization.

References

Campos J (2000) La comunicación científica: ¿arte o ciencia? *Ars Pharmaceutica,* 41(1): 11-18.

Consejo Nacional de Ciencia y Tecnología (CONACYT) (2012) *Reglamento del Sistema Nacional de Investigadores*. Available at: http://www.conacyt.mx/ (accessed 25 September 2015).

Ferreira C, Malerbo M y Silva M (2003) Errores en las referencias bibliográficas de la producción académica: un estudio de caso. *Scire: Representación y organización del conocimiento,* (9)1: 133-138.

Gorbea S (2010) *Potencialidades de investigación y docencia iberoamericana en ciencias bibliotecológicas y de la información*. México: Universidad Nacional Autónoma de México, Centro Universitario de Investigaciones Bibliotecológicas.

Hernández-Gutiérrez P (2015) *Métrica de la producción científica en universidades públicas estales mexicanas*. PhD Thesis, Universidad Autónoma de Chihuahua, México.

Instituto Mexicano para la Competitividad (IMCO) (2012) *Índice de Competitividad Internacional 2011: más allá de los BRICS*. Available at: www.imco.org.mx (accessed 25 September 2015).

López-Carrasco M (2013) *Análisis de la producción científico-tecnológica en universidades mexicanas: comparación Estado de Chihuahua y otras entidades, 2007-2011.* Master Thesis, Universidad Autónoma de Chihuahua, México.

Manjarin M, Cutri A, Torres F, Noguerol M, Ossorio M, Durán P y Ferrero F (2009) Evaluación de la producción científica en la residencia de pediatría. *Archivos Argentinos de Pediatría,* 107(1): 26-29.

Mendoza J (2009) *Financiamiento de la educación superior y crisis económica: avances y limitaciones en el presupuesto federal para las instituciones públicas de educación superior.* México: Asociación Nacional de Universidades e Instituciones de Educación Superior.

Modrego A (2002) *Capital Intelectual y producción científica*. Madrid: Comunidad de Madrid, Consejería de Educación, Dirección General de Investigación.

Muñoz-Muñoz A (2006) Producción de las profesoras de la Universidad de Granada (España) en el último cuarto del siglo XX. *Investigación* Bibliotecológica, 20(40), 170-186.

Palacios J y Vargas D (2009). *Medición efectiva de la calidad: Innovaciones en México*. México: Trillas.

Romanos S (2009) Estrategias de difusión del conocimiento en ciencias del hombre: El caso de la Facultad de Filosofía y Letras de la Universidad de Buenos Aires, proyecto UBACYT F157 (Programación científica 2008-2010). *Revista Información, Cultura y Sociedad,* 20: 91-110.

Shults F (2005) *An empirical model for assessing academic research levels and capacities of colleges and universities*. PhD Thesis, University of Tennessee, USA.

Tarango J, Hernández-Gutiérrez P y Vázquez-Guzmán D (2015) Evaluation of scientific production in Mexican state public universities (2007-2011) using principal component analysis. *El profesional de la información*, 24(5).

Universidad Nacional Autónoma de México (UNAM), Dirección General de Evaluación Institucional (2012) *Estudio comparativo de universidades públicas mexicanas*. Available at: www.ecum.unam.mx/ (accessed 25 September 2015).

Zabalza M (2004) *La enseñanza universitaria: El escenario y sus protagonistas*. Madrid: Narcea.