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## *Special Report:* *Scientific Communication*

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# Quantitative Analyses of Scientific Literature and Their Validity for Judging Latin American Production

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In his quantitative analysis of Latin American scientific literature, Garfield (1) concludes with six observations or general recommendations, of which I am in agreement with the last four. Regarding the other two, I would like to register a few philosophical, epistemological, and cultural objections to the worrisome idea that the design of a scientific policy in Latin America should begin with an elitist vision of the scientific process and make certain interpretations of the quantitative analyses.

Without a doubt, the visibility of Latin American science has increased, as reflected in the figures provided by Garfield. However, the apparent validity of the data does not mean that one must agree with the epistemological validity of applying the type of study he discusses to developing countries. Neither the apparent validity nor the instrumental validity implies theoretical validity, which is determined by qualitative, rather than quantitative, methods (2).

Garfield is aware of these problems, as he has repeatedly pointed out that the impact indicators of the Institute of Scientific Information's (ISI) *Science Citation Index*<sup>®</sup> (SCI) must be used in conjunction with other indicators. In addition, I agree with him wholeheartedly about the need for Latin America to compile a "Latin American Science Citation Index." The paragraphs that follow, in addition to describing certain disagreements with Garfield's article, are intended to point out that caution is required when considering such studies out of context. It is advisable to prevent the ill-timed proliferation in Latin America and the Caribbean of analyses that duplicate procedures used elsewhere without making the appropriate socioeconomic and institutional adjustments.

### CONTEXT AND PARADIGM

The social context of the scientific process shapes the selection of research and publication topics. For this reason, one author has asked whether it would not be more consistent with the objectives of self-sustained social development "to create, as an inseparable element of our scientific systems, organs of dissemina-

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tion that fulfill these tasks . . . that underscore our priorities and objectives and that are expressed in our own languages" (3). Out-of-context analyses such as those of the *SCI* applied to Latin American scientific endeavors may produce a degree of alienation "if in our scientific efforts we frequently imitate fads and seek recognition that makes sense only in the cultural and social context of the central countries" (3).

If, as some believe, scientific activities can only develop within the paradigms chosen by the wealthy countries, the consequence is that the Latin American countries are relegated to the status of scientific colonies. We end up ". . . confusing the international scientific community with that of the Anglo-American world, the latter becoming the only source of standards and criteria for granting or denying validity . . ." to our scientific endeavors (4).

The significance and importance of bibliometric data cannot be rigorously guaranteed because of limitations inherent to the databases examined and the procedures used. This highly relevant problem of interpretation is attributable to the fact that theoretical understanding of the true significance of bibliometric data is still poorly developed (5).

Indicators obtained from different databases may point to different conclusions with respect to the international position of a country in various scientific fields. Without a proper understanding of the scientific and hierarchical relationships among journals, it is difficult to establish a basis for comparison.

The research processes within a society—the object of measurement in scientometrics—are not entirely "objective and neutral" like a natural physical law, but rather are part of the social milieu, and as a result they vary from one society to another. The presumed objectivity of these measurements is based on implicit assumptions that are not necessarily true

in all cases. Sociologists have pointed out this cognitive limitation of citation analysis, as well as the non-normative nature of the scientific process in developing countries (6). That vision differs considerably from the predominant view in North America, which is strongly influenced by the paradigms of Robert Merton. The Mertonian school maintains that the growth of science is strongly linked to the values and perspectives of puritanism (utilitarianism and empiricism), with an elitist normative structure (the Matthew effect)<sup>2</sup> in which recognition by one's peers or colleagues is the reward. The scientist is presumed to act disinterestedly in a universalist undertaking marked by the free exchange of knowledge. The editorial corollary is that recognition of the scientist is manifested through citation of his work by colleagues from the elite class in "high-impact" journals (7).

From an epistemological standpoint, strong objections can be made to the customary interpretation of quantitative analyses of scientific literature—for example, those made by certain European schools of thought, which have shown considerable resistance to the numerical interpretations of the *SCI*.

The theoretical-conceptual grounds on which the *SCI* bibliometric analyses are based came into existence in the 1950s and 1960s under the influence of Merton, Price, Zuckerman, and Crane and were assumed and further developed by the ISI. However, in opposition to the Mertonian sociological school that prevailed in the United States of America, other currents of thought regarding the sociology of science appeared elsewhere: at the University of Edinburgh, with Barnes

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<sup>2</sup>The "Matthew effect" refers to the following passage in the Gospel According to Matthew (25:25): "For unto everyone that hath shall be given, and he shall have abundance; but from him that hath not shall be taken away even that which he hath."

and Bloor; in Sussex, with MacLeod; in Frankfurt, under the influence of Habermas; and in France, with Latour and others. Salient among the many publications in this field is the journal *Social Studies of Science*, which for decades has published analyses that do not conform to the Mertonian view.

If scientific indicators are based on the epistemological premises of the positivist version of science that emerged from the University of Chicago and Columbia University, then ". . . when these assumptions are not true, or substantially correct, the indicators lose their cognitive validity. . . . The present sociological approach . . . assumes that the formal scientific publication is but one of several means of scientific communication and by no means the most important. . . . As a logical consequence, scientific indicators must also be suspect" (8).

It is interesting to note that those who today use these scientometric techniques in Latin America do not clearly understand the extent to which they are accepting sociological paradigms that are not necessarily applicable and that might be entirely void of significance for purposes of interpreting the sociology of Latin American science. "The time has come for Latin American countries to step forward on the question of indicators and cease to be mere followers of trends and instruments that originated in the central countries" (8).

These objections are recurring themes in specialized journals, which both interpret the indicators derived from the *SCI* and point out their limitations.

## METHODS

Despite its considerable value as a bibliographic tool, the *SCI* can be misleading in evaluating the impact of scientific work (9), particularly with regard to research which is not of vital interest in dominant countries.

The following theoretical difficulties involved in the analysis of citations are worth mentioning: (a) whether the author actually used the document cited; (b) whether the citation constitutes a judgment on the merit and quality of the document; (c) whether all citations should be considered to have equal value, regardless of their purpose (a citation may have at least 10 different recognized functions [10], from the derogatory to the confirmatory, with varying degrees in between, etc.); (d) methodological problems, e.g., multiple authorship, self-citations, homographs, synonyms, implicit citations, and variations in citation practices over time and among different disciplines; and (e) errors in the citations appearing in journals (which can affect between 10% and 50% of all citations—11).

On the other hand, a real limitation of the *SCI* is the fact that neither formal nor informal communication methods outside of journals are taken into consideration, as well as the lack of recognition that publication practices vary from one country to another. The institutional pressure to "publish or perish" that is evident in the system prevailing in the United States, Canada, and Britain does not exist everywhere.<sup>3</sup> Nor is there unanimity with regard to the effect that such

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<sup>3</sup>Of authors who publish, 15% will never be cited and the mean annual number of citations per article is only 1.7. Apart from a core group of the most cited articles, the large majority of articles are cited only rarely, a fact more characteristic of a stochastic occurrence than related to quality. Of some 3 000 journals analyzed in the *SCI*, less than 200 that unarguably constitute the elite garner 50% of the citations. The median band, occupied by several hundred journals, has a citation distribution that fluctuates from year to year and whose interpretation runs into technical difficulties (11). The "tail" of the distribution contains journals whose marginal presence is dependent on the initial selection of titles and the interpretation of their presence or absence, and their assessment in the *SCI* appears to be clearly irrelevant.

pressure has on the quality of scientific literature.

The results of applied research, such as that conducted in the agricultural sciences, tend to be of local or regional interest and are not normally communicated through formal international channels. In Brazil, more than 80% of all agricultural research is published in national journals (12). For its part, the *SCI* is considerably biased in favor of research in the basic sciences conducted in heavily industrialized, primarily English-speaking countries. In addition, the *SCI* almost totally ignores material not published in journals: reports, patents, "gray literature" in general. Nor does it take into account presentations made in international conferences, the ability to obtain research grants from outside the researcher's own country, and other indicators of professional esteem—all of which are of central importance when assessing the extent of scientific endeavor in Latin America and the Caribbean.

Tropical research activities, in all disciplines, emanate primarily from developing countries. For example, more than 85% of research on tropical livestock production is conducted in developing countries, particularly in Latin America (13). The *SCI* scarcely includes these areas of research, whereas in the French database PASCAL more than 60% of bibliographic production in the area of tropical agricultural sciences involves information produced in peripheral countries. This same gap in the *SCI* is also apparent in such fields as parasitology, soil science, alternative technologies, and public health, to name a few examples.

A further methodological problem that detracts from the validity of the indicators proposed in Garfield's article is that the analyses pertain to groups of countries, without taking into account the particular environments and social conditions prevailing in each individual country or the differences existing among the var-

ious research disciplines. These "consolidated figures" mask the contributions of developing countries in specific areas of knowledge on which they might be focusing their scientific efforts (14).

One of the most salient findings of the analyses conducted with regard to scientific literature in developing countries is the existence of strong local partnerships as well as regional cooperation through international institutions, whose publications are frequently not recorded in the *SCI*. It should be pointed out that the *Boletín de la Oficina Sanitaria Panamericana/Bulletin of the Pan American Health Organization*, in which both this article and the article it comments on are published, are not indexed in the *SCI*.<sup>4</sup> In many cases, international cooperation takes the form of co-authorship arrangements between local authors and authors from the old colonial European powers. It is interesting to observe that the countries that were at one time under British colonial rule are better represented in the *SCI* than francophone and Latin American countries, due to the ISI's language-based selection process (15).

It has been pointed out that the status of scientific research in the peripheral countries may be more appropriately analyzed by examining a number of different specialized international databases in addition to the *SCI*, since these other databases are much more comprehensive in terms of international literature and include a greater proportion of local journals. Of the more than 3 000 titles analyzed by the *SCI*, less than 100 are from

<sup>4</sup>Other journals, such as *Cadernos de Saúde Pública* (Rio de Janeiro), *Cuadernos Médicos-Sociales* (Rosario, Argentina), *Cuadernos Médicos-Sociales* (Santiago, Chile), *Gaceta Sanitaria* (Barcelona), *Revista de Sanidad e Higiene Pública* (Madrid), and *Revista de Saúde Pública* (São Paulo)—in other words, the great majority of all of the public health journals published in the Spanish and Portuguese languages—are likewise not indexed in the *SCI*.

Third World countries and only a dozen or so are from Latin America and the Caribbean. On the other hand, the MEDLINE database alone records 42 Latin American titles in the biomedical sciences. Of the few Third World journals that are included in the *SCI*, most are in English and pertain to biomedicine, to the detriment of other disciplines (16).

## ACCESSIBILITY AND CENTRAL-PERIPHERAL COMMUNICATION

In addition to all the previous considerations, it must be emphasized that one of the central premises in citation analysis is that the author cites works because they are the best or most representative on a particular topic. This presupposes that the author analyzes carefully all citable documents and selects only the best. However, studies have shown time and again that *accessibility* is one of the most important factors in determining the selection of a source of information to be cited.

The accessibility of a document is a function of its language, its place of origin, its form, and the commercial or institutional network supporting it (17). An article is accessible when it is available in a nearby library, in databases, or in the form of photocopies provided through interlibrary loans or through commercial suppliers and, above all, when it exists in a language understood by the researcher. Accordingly, in real life an article ends up being cited because it is found on the desk or in the library closest to the person doing the citing, not because it is the best or the worst or because its contents have the greatest "impact." This was the thesis of Maurice Line, former Director General of the British Library Lending Division, the largest institution in the world supplying photocopies of journal articles (18).

Researchers in the central countries cite few or no works from peripheral nations.

In order to be able to infer something with regard to quality from this fact, we must begin with the assumption that international communication in the scientific community is perfect along the North-South axis in both directions, an assumption that is hardly sustainable.

Calculation of the insularity index of citations (the proportion of citations of publications from the writer's own country with respect to total citations) shows that the index is very low in Latin American countries as compared to the United States (70%), whose extreme insularity is consistent with the "tibetization" of its science (19). As a rule, the English-speaking community is relatively impervious to anything not published in English. The selection of titles by the ISI, which is a commercial enterprise oriented toward its primary market, reflects the prevailing "tibetization" of U.S. scientific culture.

The asymmetry in the North-South flow of scientific communication is also influenced by other marketing or rating considerations. It is obvious that publishers in Latin American countries cannot compete with the publishing industries of First World countries, and likewise lack the same marketing ability, advertising sponsors, and market penetration. This scenario is true not only for journals, but also for television networks, the Hollywood movie industry, soft drinks, etc.

In addition, given the competition for space in the journals of the industrialized countries, it is highly unlikely that research reports that are not in tune with the research priorities of those countries' national agendas will be accepted for publication. This is neither a criticism of the system nor a political judgment, but rather a statement of fact. Much of the financing granted by governments of the central countries to universities, or awarded as research contracts to corporations, is based on the political priorities—and in many cases, on the defense interests—of those countries. The jour-

nals that the *SCI* considers to be “elite” are inseparably linked to institutions with extremely strong publishing arms, and it is only logical that those journals should be the outlets for the results of such research efforts.<sup>5</sup>

The journal *Science* is the mouthpiece of the American Association for the Advancement of Science, one of the largest scientific associations in the Western world; *JAMA*, formerly known as the *Journal of the American Medical Association*, is the journal of one of the most important medical societies in the entire world; and so on. The “elite” definitely reflect the interest agendas of the First World countries. It is not surprising, then, that in recent months these journals have dedicated more space to the “Duesberg polemic” with respect to the relationship between HIV and AIDS than to the discovery and development in Colombia of an anti-malarial vaccine, donated to WHO. Although malaria affects some 600 million people worldwide, the “elite” journals reflect the priorities of industrialized countries and the interests of the extremely powerful U.S. AIDS lobby.

Except when producing work of exceptional quality, more often than not developing-country researchers achieve visibility only if they explore subjects of interest to wealthy countries, or if they establish an association with the institutions of those countries and publish jointly in their journals—naturally, in their language. When a Latin American author manages to get published in “elite” journals, it demonstrates not only the quality of his work but something more important: that he has been able to overcome structural, cultural, linguistic, political-philosophical, geographic, and ethnic barriers and penetrate the networks that

give him credibility as a researcher, despite the fact that he is not associated with an elite institution. When these barriers are not breached, the only outlet for research related to the national or regional needs of Latin America and the Caribbean is local journals; of course, such journals have no “window” in the *SCI*, which indexes only what its parent institution considers to be “elite international literature.”

Particularly in the area of medical science, it is neither easy nor always possible to obtain reliable scientific research indicators for purposes of inter-country comparisons based solely on the indexed medical literature and ignoring such other variables as financing, human resources, etc. On the other hand, a strongly positive correlation has been postulated between the levels of research and the quality of health care. This correlation may reflect not only a direct relationship between clinical research and the quality of medical care but also the fact that the general development of a country determines both the level of medical research and the level of social welfare (20). In addition, the health indicators of societies may reveal the submerged portion of the iceberg of health research, which escapes the bibliometric “window” of the *SCI*.

## REFLECTIONS AND CONCLUSIONS

The epistemological question of whether the literature of a specialty adequately reflects, by itself, the progress achieved in a particular scientific discipline has yet to be resolved (21). The limitations that hamper comparison of citation indices and impact factors among various disciplines or countries can be overcome through the use of more elaborate analytical instruments, such as *relative indicators* that consider several dimensions or variables simultaneously (22). There are several

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<sup>5</sup>Examples are the dozens of university publishing houses with names ending in “University Press,” such as Johns Hopkins, Harvard, Yale, Chicago, Oxford, Columbia, Carnegie-Mellon, etc.

indices of this type (activity index, attraction index, relative rate of citation, insularity index, dissemination index, production in circulation, co-citations within the discipline, etc.), which must also be supplemented with demographic, economic, and educational data. These multidimensional indicators have lower error levels and provide more reliable statistics than do the unidimensional indicators normally drawn from the *SCI*. With a view to cost-benefit evaluation, the above-mentioned relative indicators make it possible to determine whether the efforts invested by a society in developing a given field of research yield appropriate returns, as measured by their relative impact. This type of analysis reveals that small nations such as Denmark, the Netherlands, and Switzerland are much more effective in terms of the social return on their research investments than are the large central countries with their more powerful economies and their widely circulated "high-impact" journals (23).

Considering benefit for cost, it could be said that Latin American countries have also been much more effective than the central countries in terms of the results of their research investments. The United States and the European Community invest between 40 and 50 times more money than Latin America to produce only 20 to 25 times as many publications (24). A dollar-for-dollar comparison shows that, in terms of the use of resources and their corresponding returns to society, Latin America is ahead of the elite countries; during the past five years, the growth rate of patent applications was greater in Latin America than in the United States or the European Community (24).

Multidimensional indicators are more appropriate than citation impact to compare research institutions of varying sizes. In addition, the indices used by the *SCI*, even when corrected to reflect the number of citable articles published, do not erase the advantage that large entities

(countries, institutions, journals, etc.) have over smaller entities (25).

Proper appreciation of the Latin American and Caribbean scientific effort requires an approach different from the *SCI*, one that is premised on sociological bases more in line with the regional reality. Otherwise, Latin American scientific literature will continue to be viewed only through the rosy glass of a small window that happens to be in Philadelphia, aimed from its inception at another market.

For the above reasons, some of the conclusions in Garfield's article are of concern. The article recommended that government and university decision-makers make use of the "unique and systematic overview" provided by quantitative analyses of the literature, such as that based on the *SCI*, and suggested the preferential allotment of resources to the "elite force" in the research community. But to view Latin American and Caribbean scientific production with foreign eyes, in a way totally unrelated to the social and economic context of the region, could have devastating effects, particularly for small- and medium-sized institutions or incipient research efforts struggling with myriad difficulties. Instead of bolstering research, it could end up undermining the painstaking construction of a network of researchers in Latin America and the Caribbean and the social infrastructure that sustains it.

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### **Dr. Garfield replies:**

Ernesto Spinak has used the occasion of my recent paper in the *Bulletin of the Pan American Health Organization* 29(1):87-95, 1995, to launch a philosophical po-

lemic about the validity of quantitative indicators in the Third World and, in particular, to challenge the relevance of the *Science Citation Index*® for that purpose. In doing so, he rehashes the now ancient claims about the real and imagined short-



comings of citation analysis. However, he never specifically identifies what is concretely wrong with the data.

Nevertheless, his comments will resonate with many in the Third World who perceive some sort of conspiracy by abstracting services to deny smaller countries their proper recognition. It is significant that those who make these assertions are generally not scientists who produce internationally significant research.

Yes, I have recommended the creation of a Latin American or Third World *Science Citation Index*. Its creation may provide evidence to support the as yet unproved claims that certain journals ought to be covered in more abstracting services. However, it will not change the fact that Latin American scientists publish their best work in international journals. They may also publish in national journals for a variety of legitimate purposes,<sup>1</sup> but to achieve the international recognition they seek, they will increasingly publish in international or regional journals. In the past decade, dozens of European journals have been created. I have repeatedly suggested the creation of regional Latin American journals that could achieve a critical mass and thereby

receive greater attention than the dozens of small, fragmented journals now published.

As my report demonstrated, these trends have increased. Spinak does not question the validity of *SCI* data with respect to Latin America. Incidentally, a Latin American *SCI* may ameliorate the feelings of journal editors who are now excluded, but such a database will be diminished in value if it does not include the *SCI* data reporting the participation of Latin American scientists in the international journals. During 1981–1994 the *SCI* indexed over 110 000 articles from Latin America. Of these, 10% were published in 1994 alone, and in 1995 this recent proportion continues to increase. Affirmative action by local research authorities in supporting local scientists' efforts to publish their work in the international media will enhance their contacts with worldwide networks of scientists.

Spinak makes unsupported allegations about error rates in citations.<sup>2</sup> He provides no documentation for these and other statements. Typographical errors rarely affect the use of bibliometric data for measuring national productivities or the impact of individual journals.

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<sup>1</sup>Sanz F, Aragon I, Mendez A. The function of national journals in disseminating applied science. *J Inf Sci* 1995;21(4):319–323.

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<sup>2</sup>*Editor's note:* The reference (11) for the error rate statistics was subsequently requested and provided by Mr. Spinak.