The Google Scholar Experiment: How to Index False Papers and Manipulate Bibliometric Indicators

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Google Scholar has been well received by the research community. Its promises of free, universal, and easy access to scientific literature coupled with the perception that it covers the social sciences and the humanities better than other traditional multidisciplinary databases have contributed to the quick expansion of Google Scholar Citations and Google Scholar Metrics: 2 new bibliometric products that offer citation data at the individual level and at journal level. In this article, we show the results of an experiment undertaken to analyze Google Scholar's capacity to detect citation-counting manipulation. For this, we uploaded 6 documents to an institutional web domain that were authored by a fictitious researcher and referenced all the publications of the members of the EC3 research group at the University of Granada. The detection by Google Scholar of these papers caused an outburst in the number of citations included in the Google Scholar Citations profiles of the authors. We discuss the effects of such an outburst and how it could affect the future development of such products, at both the individual level and the journal level, especially if Google Scholar persists with its lack of transparency.

Introduction

When Google Scholar (hereafter GS) irrupted within the academic world it was well received by researchers. It offered free, universal access, using a simple user-friendly interface, to all scholarly documents available under an academic domain on the web and covered document types, languages, and fields that were under-represented in the main multidisciplinary scientific database at the time: Thomson Reuters's Web of Science (Kousha & Thelwall, 2011; Harzing & van der Wal, 2008). In less than 10 years, GS has positioned itself as one of the main information sources for researchers (Nicholas, Clark, Rowlands, & Jamali, 2009; Brown & Swan, 2007; Joint Information Systems Committee, 2012). The extolled capabilities of Google's algorithm to retrieve pertinent information along with the popularity of the company seem to have been inherited by GS (Walters, 2011). However, this does not explain all of its success. The deep changes occurring in scholarly communication, such as the open access or data sharing movements, have contributed to such success, benefiting all parties. For instance, on the one hand, GS has given repositories the visibility they were lacking (Markland, 2006) and, on the other hand, these repositories have provided GS with unique content no other scientific database has (preprints, theses, etc.; Kousha & Thelwall, 2007), making it a valuable resource.

In 2011, GS took a major step signaling its intentions toward research evaluation when it launched GS Citations, which offers citation profiles for researchers (Butler, 2011), and, 1 year later, GS Metrics, which offers journal rankings according to their h-index for publications from the last 5 years (Delgado López-Cózar & Cabezas-Clavijo, 2012). The inclusion of these tools has popularized the use of bibliometrics, stimulating researchers' egos (Cabezas-Clavijo & Delgado López-Cózar, 2013; Wouters & Costas, 2012) and challenging the minimum requirements demanded by bibliometricians to rely on any data source for bibliometric analysis (Aguillo, 2012). Such appeal may be explained by the need researchers have to respond to evermore demanding pressures to demonstrate their impact in

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order to obtain research funding or to progress in their academic career, especially in fields of the social sciences and humanities; they see in these products a solution to their lack of visibility in the traditional databases (Hicks, 2004).

Soon, bibliometricians turned their interest to this database and many studies emerged analyzing the possibilities of using such a database for bibliometric purposes (i.e., Meho & Yang, 2007; Aguillo, 2012; Torres-Salinas, Ruiz-Perez, & Delgado López-Cózar, 2009). Mainly, these studies have criticized these tools due to inconsistencies in citation counting (Bar-Ilan, 2008), metadata errors (Jacsó, 2011), and lack of quality control (Aguillo, 2012). These limitations are also present in their by-products. The main reservation, however, when considering GS and its by-products for research evaluation has to do with the lack of transparency (Wouters & Costas, 2012). This is an important limitation as it does not allow us to certify that the information offered is, in fact, correct, especially when trying to detect or interpret strange bibliometric patterns. GS automatically retrieves, indexes, and stores any type of scientific material uploaded by an author without any previous external control—meaning that any individual or collective can modify their output, which then impacts directly on their bibliometric performance. Hence, the new GS products raise ethical and sociological dilemmas that may entail serious consequences in the world of science and research evaluation.

The inclusion of bibliometric tools applied in an uncontrolled environment, as GS proposes, has led to another type of critical study, experimenting with their capacity to distinguish between real academic content from faked content. In this regard we refer to the study undertaken by Labbé (2010) and his nonexistent researcher, Ike Antkare, who proved how easily computer-generated tools for research evaluation can be manipulated. In similar studies, Beel, Gipp, and Wilde (2010) and Beel and Gipp (2010) tested different procedures with which to influence GS results and obtain higher ranking positions, and hence more visibility. Among other procedures, they used SCIgen software (http://pdos.csail.mit.edu/scigen/) to create fake papers; they included modifications of previously published papers adding new references; and they included duplicates of other papers.

Studies such as these alerted researchers to the ease with which the GS search engine could be manipulated, which means such threats had already been stressed before the launch of GS Citations and GS Metrics. Although abuses have also been reported in other databases, such as including so-called "predatory publishers" (Harzing, 2012) or simply by manipulating journals' impact factor (Opatrný, 2008), the lack of any type of control or transparency in GS is certainly worrying as this tool becomes more and more popular within the research community (Bartneck & Kokkelmans, 2011).

In this article, we report our main findings and conclusions after conducting an experiment to analyze GS and its by-products' capabilities to detect manipulation in the most rudimentary version. We focus on the effects this experiment has had on GS Citations and warn of the implications such attitudes could have on GS Metrics' rankings, as this type of behavior by which someone modifies output and impact through intentional and unrestrained self-citation is not uncommon (see, e.g., Oransky, 2012). Therefore, our aim is to demonstrate how easily anyone can manipulate GS tools. We will not emphasize the technical aspects of such gaming, but rather its consequences in terms of research evaluation, focusing on the enormous temptation these tools can have for researchers and journal editors being urged to increase their impact. In order to do so, we will show how the GS Citations profiles of researchers can be modified in the easiest way possible: by uploading faked documents to our personal website citing the entire production of a research group. No software program is needed; you only need to copy and paste the same text over and over again and upload the resulting documents to a webpage under an institutional domain. We will also analyze Google's capacity to detect retracted documents and delete their bibliographic records along with the citations they make. This type of study, challenging a given system to detect errors or flaws, is common in the scientific literature: for example, the classic studies of Peters and Ceci (1982) or Sokal (1996) criticizing the peer-review system and its inability to detect fraud in science.

This article is structured as follows. First, we describe our method: how the false documents were created and where they were uploaded. Then we briefly describe our target-service, GS Citations. Second, we show the effect the inclusion of false documents had on the bibliometric profiles of the researchers who received the citations. We expose the reaction of GS after such manipulation was made public and we discuss the consequences GS's lack of transparency and easiness to manipulate may have if used as a research evaluation tool. Finally, we offer some concluding remarks.

Material and Methods

The main goal of this experiment was to analyze the difficulty of including false documents and citations in GS, the consequences such actions have on its by-product GS Citations, and how this would have affected GS Metrics if updated at the time.

GS Citations was launched in the summer of 2011 (Butler, 2011) and made publicly available to all users in November of that same year. It has greatly expanded since then, with an estimated total population of up to 72,579 users in less than a year, according to Ortega and Aguillo (2013). It adopts a micro-level approach, offering each author their own research profile according to the contents derived from GS (Cabezas-Clavijo & Delgado López-Cózar, 2013). Authors can create their own profile by signing in and including an institutional e-mail address. Then, GS Citations automatically assigns documents retrieved from GS to the user, who can edit his or her bibliographic information, merge duplicates, include omitted papers, or remove wrong papers. It offers the total number of citations to each document according to GS, ranking the output by times cited or

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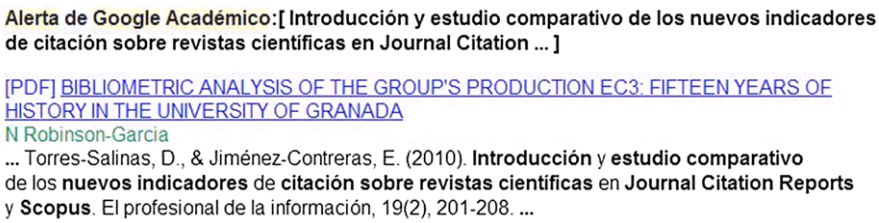

FIG. 1. E-mail alert received by the authors informing them of a new (false) citation to one of their articles. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

publication year. Finally, it includes a histogram of citations received by year and several bibliometric indicators (total number of citations, h-index, and i10 index). Authors also can select their own keywords to label their research field, allowing them to visualize research fields not as classified by a third party, as occurs in other databases, but as seen from the researcher's own perspective (Ortega & Aguillo, 2012).

In order to manipulate citation counting, we adopted the most simple and rudimentary strategy we could think of. We selected the authors of this article (Emilio Delgado López-Cózar, Nicolás Robinson-García, and Daniel Torres-Salinas; hereafter EDLC, NRG, and DTS) and the rest of the members of our own research group (EC3: Evaluación de la Ciencia y de la Comunicación Científica) as the target-sample. Then we drafted a short text, copied and pasted more from the research group's website (http://ec3.ugr.es), and included several graphs and figures. Finally, we translated it into English using Google Translate.

As a first step, and in order to test the chances the experiment had of succeeding, a paper written by NRG (available at http://hdl.handle.net/10481/24753) was uploaded at the end of January 2012, referencing 36 publications authored by DTS. On February 18, 2012, DTS received an e-mail from GS Citations informing him that all his papers had been cited by NRG (in Figure 1 we show the message he received for one of his papers).

Taking into consideration the effects of this first attempt, we divided the same text into six documents. At the end of each document we included references to the whole research production of the EC3 research group. In each document we preserved a similar structure to that of publications: including a title and a small abstract as well as the author. In Figure 2 we show a screenshot of the first page of some of the false papers.

We created a fictitious researcher named Marco Alberto Pantani-Contador, making reference to the Italian cyclist who faced many doping allegations throughout his career and the Spanish cyclist who has also been accused of doping several times. Thus, Pantani-Contador "authored" six documents not intended to be considered as published papers, but simply as documents made publicly available. Each document referenced 129 papers authored by at least one member of our research group. That is, we expected a total increase of 774 citations.

On April 17, 2012 we created a webpage in HTML under the institutional web domain of the University of Granada (ugr.es) including references to the false papers and linking to their full text, expecting Google Scholar to index their content. We excluded other services such as institutional or subject-based repositories as they are not obliged to undertake any bibliographic control rather than a formal one (Delgado López-Cózar & Robinson-García, 2012) and we did not seek to bypass their filters.

Effects and Consequences of the Manipulation of Citation Data

Google indexed these documents nearly a month after they were uploaded, on May 12, 2012. At that time the members of the research group used as our case study, including the authors of this article, received an alert from GS Citations noting that someone called MA Pantani-Contador had cited their output (http://hdl.handle.net/10481/24753). The citation explosion was thrilling, especially in the case of the youngest researchers whose citation rates multiplied by six, increasing the size of their profiles. Table 1 shows the increase in citations the authors experienced. Obviously, the number of citations by author varies depending on the number of publications each member of the research group had as well as the inclusion of real citations received during the study period.

Thus, the greatest increase is for the less-cited author NRG, who receives 7.5 times as many citations, while DTS doubles his count, and EDLC experiences an increase of 1.5. We also include the variations in the h-index of each researcher. While the most significant increase is for the least prolific profile, the variation for the other two authors is much more moderate, illustrating the irrelevance that citations have to papers once they belong to the top h (Costas & Bordons, 2007). Note how in DTS's case, where the number of citations nearly doubles, the h-index only increases by 2. On the other hand, we observe that the i10-index is much more sensitive to changes. In DTS's case, the increase goes from 7 to 17, and in EDLC's case it triples for the last 5 years, going from 11 to 33. In Figure 3 we include a screenshot of the GS Citations profile for the one of the authors before and after Pantani-Contador's citations were included.

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THE EC3 RESEARCH GROUP PAPERS

by Marco Alberto Pantani-Contador

Abstract

This study analyzes trends in production and co-authorship of scientific articles production of the research group "Evaluation of Science and Scientific Communication", University of Granada as a result of its 15th anniversary. It notes that its members and publications, and works before the birth of the group itself, dating from 1986 publications. 125 publications have been recovered and identified four authors more active than the rest and have participated in a personal capacity between 25% and 55% of total group output. In addition, it identifies the most common partners and their participation rate of around 5%.

Introduction

The research group Evaluation of Science and Scientific Communication at the University of Granada, HUM-777 coded according to Scientific Information System of Andalusia, has achieved over the last decade become a reference in the field of bibliometrics to the national levelIts activities not only scientific, but widely known and disseminated within the Spanish territory. led by Professor Evaristo Jiménez-Contreras Documentation, has thirteen members of which four have a core of very active members. Regarding not only by their scientific and educational, but also as disseminators, dating from 2005 EC3 News blog (http://ecsnoticias.blogspot.com) that has gone on to become an agenda of their work.

This work aims to include a brief analysis of his scientific journey through publications in scientific journals from 1986 to 2011. In this section we describe the group's objectives and main lines of research pursued. Section 2 outlines the specific objectives of this work. Section 3 shows the methodology used. Section 4 shows the results and then discuss in Section 5.

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AN INTROSPECTIVE LOOK: FIFTEEN YEARS AFTER

by Marco Alberto Pantani-Contador

Abstract

This work aims to include a brief analysis of his scientific journey through publications in scientific journals from 1986 to 2011. In this section we describe the group's objectives and main lines of research pursued. Section 2 outlines the specific objectives of this work. Section 3 shows the methodology used. Section 4 shows the results and then discuss in Section 5.

Introduction

The project research framework of this group is to contribute, from different perspectives, assessment processes of science and scientific communication and knowledge of their behavior patterns.To do this, develop a body of research focused on analyzing and evaluating the results of research activity, seen mainly through scientific publications and using, but not limited to, procedures and cutting bibliometric quantitative techniques.

Although the measurement and evaluation of scientific activity is a multidimensional aspect, it is assumed, as part of the theory of science that the expectations generated by the research results to be assessed by the scientists themselves are very approximate indication of the impact, relevance and quality of research. Value judgments is exerted from the system itself and located at certain times of the cycle of scientific production. If the timing is the dissemination of results, the most suitable materials for the evaluation are, without doubt, the research articles themselves that publish scientific journals and reports and reports generated by research projects and this for several reasons. On the one hand, journals applying a selection process and original valuation in theory should lead to acceptance for publication papers that meet a certain standard of quality. In other research projects have deserved to be supported, subject also selective process, disclose their contributions and / or utilities, either by publication or by internal reports. And finally, in the consumption process of science, the scientific impact of publicized research is endorsed and enhanced by other scientists through the recognition and acceptance of its influence in the act of scientific method known as the citation, where the citations received by a job are a reflection of acceptable or satisfactory quality. In this sense, their work and the tools derived therefrom, are located in the so-called ex-post evaluation of science, that is, one that is done to measure the quality, counseling, outreach and impact of their results, aiming ultimately instance, provide a set of indicators to help the management of a country's scientific policy. Its main lines of research are: (1) evaluation of science in Spain, (2) evaluation of scientific journals and (3) studies and bibliometric methodology.

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ANALYZING A SOCIAL SCIENCES RESEARCH GROUP'S PUBLICATIONS: A CASE STUDY

by Marco Alberto Pantani-Contador

Abstract

This study aims to provide an overview and direction to be taken by the group in terms of scientific production and will reveal a greater degree of internal work flows and relationships that exist between its members.

Introduction

The aim of this study is to analyze the temporal development that has taken the group EC3 in the production of scientific articles from its inception until 2011. To do this we consider the following specific objectives:

1. Has maintained a stable release rate over time? What is the publication bias of the group?
2. Do you see in the literature of group dynamics? What degree of co-authorship between members of the group? What are the most productive authors?
3. Is there a dynamic open to collaboration with other research groups? Who are the collaborators outside the group? Do they have a higher impact index collaborations with scientists outside the research group?

This study aims to provide an overview and direction to be taken by the group in terms of scientific production and will reveal a greater degree of internal work flows and relationships that exist between its members.

Materials and methods

We performed a descriptive analysis of the scientific production of research papers EC3 research group at the University of Granada. This is used as a source of information the group's own website (http://ec3.ugr.es). Data is exported to a spreadsheet Microsoft Excel 2007 and the relevant calculations are performed to extract the following indicators:

Art / year. Average of scientific articles published each year analyzed.

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HOW DO WE COLLABORATE: THE INSIGHTS OF EC3'S COLLABORATION PATTERNS

by Marco Alberto Pantani-Contador

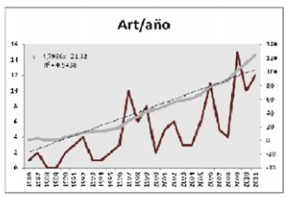
Abstract

This study aims to provide an overview and direction to be taken by the group in terms of scientific production and will reveal a greater degree of internal work flows and relationships that exist between its members.

Results

EC3's research group at the University of Granada has published a total of 125 scientific articles, whose publication date is from 1986 to 2011.With an average of five items per year. Rising to 8.6 articles per year if we restrict ourselves only to the last five years. The upward trend of publication is as shown in Figure 1 with some irregularity for years, but always growing.

[0] Figure [1]1.[/1][/0] Temporal evolution in the publication of scientific articles



The average number of authors per paper is 2.54. A total average with the average balance in the Social Sciences area around 3 authors per article. Furthermore, it should affect that except for an article signed by 12 researchers, no one over 6 authors (2 jobs) and that when the

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DISCUSSING OUR ORIGINS

by Marco Alberto Pantani-Contador

Abstract

This work aims to provide an overview of the history of the group EC3 at the University of Granada throughout its history. It looks at developments in the publication of articles in scientific journals and the degree of participation in the authorship of the work by its members.It also discusses the collaboration with researchers from outside the research group.

Introduction

The research group is three lines, namely: assessment of science in Spain, evaluation of scientific journals and bibliometric studies and methodology. The first has the following objectives. Generate cutting tools analyzing bibliometric scientific impact of publications of Spanish researchers allow scientific policy makers at various levels (national, regional, institutional) to evaluate the research performance of programs, systems, people or institutions. Evaluate the productivity, performance and scientific impact of researchers, institutions and Spanish scientific communities. Conduct studies to better understand the generation, dissemination, visibility and impact of national and international scientific production of various actors of science in Spain. This line has produced and is producing several books and articles in national and international journals, dissertations, and various projects, research agreements and contracts, among which include the following: Development of the impact factors of Spanish Journals Social Sciences and the Spanish Journal of Health Sciences. Evaluation of the promotion of research of the FIS (Health Research Fund), the body responsible for financing the Spanish research in health sciences. Bibliometric analysis of research on strategic plans for hospital complexes such as the University Hospital of Navarra and the Hospital General Universitario de Valencia. Analysis of scientific activity in the Region of Murcia.

The second line of research relates to evaluation of scientific journals.Among its objectives or ptimizar quality scientific journals, in general, and especially Spanish, adapting their editorial processes to the guidelines and standards governing international scientific communication and criteria prevailing in different scientific fields, is a fundamental element in the transfer of scientific information and, therefore, national and international dissemination of science.In this regard we intend to: improve the level of standardization of Spanish scientific journals raising the quality of their editorial processes of production and quality of information and media improved scientific journals according to criteria for selection of large databases, improve the spread and impact of Spanish scientific journals.Improve standards of presentation and preparation of scientific journals. The conclusions derived from our studies provide recommendations to raise the standards institutes and societies responsible for the

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LOOKING THROUGH THE MIRROR: A BIBLIOMETRIC ANALYSIS

by Marco Alberto Pantani-Contador

Abstract

This work aims to provide an overview of the history of the group EC3 at the University of Granada throughout its history. It looks at developments in the publication of articles in scientific journals and the degree of participation in the authorship of the work by its members.It also discusses the collaboration with researchers from outside the research group.

Introduction

P resentation of Section Bibliography of scientific articles.Study and assessment titles, name of the author, abstract, keywords.The names of Spanish authors and their treatment in international databases. The names of the organizations or institutions: standard presentation and the problem of allocating the institutional affiliation of the authors. The methods of citation (appointment systems) The presentation of the references (the bibliographical apparatus).Of special interest is to describe the bibliographic fields that focus on errors in referencing and citation (authors, titles, magazines, ...), identification data to understand the mechanisms that lead to the corruption of the references and establish a model m explaining them.

This line has led to the publication of several books and articles in national and international journals and has led, through various research projects and contracts the evaluation of nearly 350 Spanish scientific journals, among which are the following: all Spanish biomedical journals, journals published by university presses such as: Complutense de Madrid, Granada, Salamanca, Cadiz, Leon and the Basque Country, Spanish mathematics journals, some of the medical journals formerly published by Masson Publishing Group Garsia : Gaceta Sanitaria, Spanish Journal of Digestive Diseases, Progress in Obstetrics and Gynecology and various journals in different fields of knowledge (dentistry, ophthalmology, nursing) sponsored by professional associations and scientific societies.

We have also advised, although this activity has not led to the development of a report, journal Journal of Neurology, The Professional Information Bulletin Andalusian Association of Librarians, Modern Greek Studies and the Basque Government publications

Finally, our interest in the study of bibliometric methodology focuses on theoretical studies and methodological proposals for improving quantitative cutting bibliometric analysis (bibliometric laws, method of related words, social network analysis). Carry out bibliometric

FIG. 2. Screenshot of the publications authored by M.A. Pantani-Contador. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

It is also interesting to analyze the effect this citation increase may have on the h-index for journals. For this, we have considered the two journals in which the members of the research group have published most papers and which, therefore, might be more sensitive to manipulation. These are *El Profesional de la Información*, with 30 papers published, and *Revista Española de Documentación Científica*, with 33 papers. In Table 2, we show the h-indexes for both journals according to Google and the increases they would have had if the citations produced by Pantani-Contador had been included. We observe that *El Profesional de la Información* would have been more influenced, as seven papers would surpass the 12-citations threshold—increasing its h-index and raising its ranking for Spanish-language journals from position 20 to position 5. *Revista Española de Documentación Científica* would slightly modify its position, as only one article surpasses the nine-citations threshold that influence its h-index. Even so, and due to the high

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TABLE 1. Citations, h-index, and i10-index values according to Google Scholar Citations before and after false citations were included.

Author research profile	Time period	Bibliometric indicators: No. citations — Before and after manipulation			h-index — Before and after manipulation			i10-index — Before and after manipulation		
Emilio Delgado López-Cózar	**All years**	862	→	1,297	15	→	17	20	→	40
	Since 2007	560	→	995	10	→	15	11	→	33
Nicolás Robinson-García	**All years**	4	→	29	1	→	4	0	→	0
	Since 2007	4	→	29	1	→	4	0	→	0
Daniel Torres-Salinas	**All years**	227	→	416	9	→	11	7	→	17
	Since 2007	226	→	415	9	→	11	7	→	17

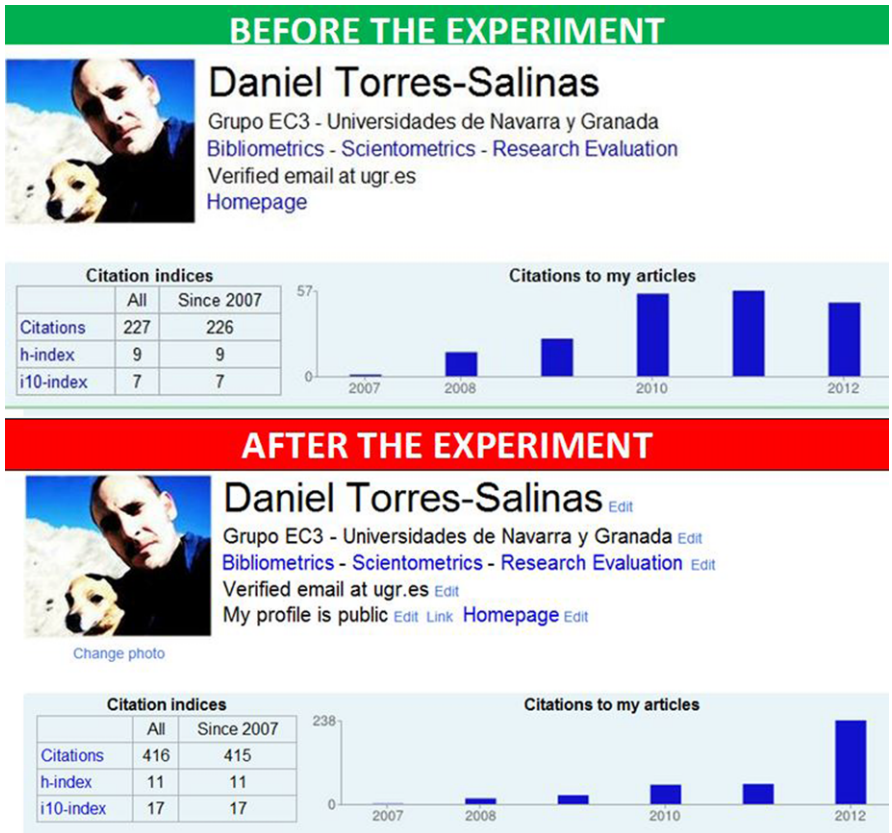

FIG. 3. Screenshot of the Google Scholar Citations profile of one of the authors before and after the Google Scholar experiment took place. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

number of journals with its same h-index, it would rise from position 74 to 54.

But these are not only the journals affected. As observed in Table 3, 51 journals had their citations increased. In this list we find journals such as *Scientometrics*, with 10 papers which had an increase of 60 citations, *JASIST* where 3 papers increased their citations by 18, or the *British Medical Journal* where one paper received six false citations. Regarding the authors, not only the targeted group was affected by this gaming, but also all their coauthors, affecting a total of 47 researchers.

TABLE 2. Effect of the citation manipulation on journals.

Journal	h5-index (GS Metrics)	Art > h5-index citation threshold	Manipulated h5-index
El Profesional de la Información	12	7	19
Revista Española de Documentación Científica	9	1	10

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TABLE 3. Publications affected by citation manipulation and increased number of citations by authors and journals.

Authors	Pubs	Citations	Journals	Pubs	Citations
Delgado López-Cózar E	72	435	Prof Inform	25	150
Jiménez Contreras, E	58	348	Rev Esp Doc Cient	18	108
Ruiz Pérez, R	36	216	Boletín de la Asociación Andaluza de Bibliotecarios	11	66
Torres-Salinas, D	32	189	Scientometrics	10	60
Bailón Moreno, R	18	108	Rev Esp Salud Public	4	24
Ruiz Baños, R	18	108	Anales de Medicina Interna	3	18
Cabezas-Clavijo, A	8	48	J Am Soc Inf Sci Tec	3	18
Moneda Corrochano, M	8	48	Anuario Thinkepi	2	12
Jurado Alameda, E	7	42	Apuntes de Ciencia y Tecnología	2	12
Moya Anegón, F	7	42	Aula Abierta	2	12
Courtial, JP	6	36	Cataloging & Classification Quarterly	2	12
Robinson-García, N	4	25	Ingeniería Química	2	12
Cordón García, JA	4	24	Knowl Organ	2	12
Herrera, F	4	24	Psychology Science Qu	2	12
Giménez Toledo, E	3	18	Revue de Bibliologie. Schémas et Schematisation	2	12
Moreno-Torres, JG	3	18	Anales de Documentación	1	6
Ferreiro Aáez, L	2	12	Arbor	1	6
Herrero Solana, V	2	12	Archivos de la Sociedad Española de Oftalmología	1	6
López-Herrera, AG	2	12	Biblio 3W, Revista Bibliográfica de Geografía y Ciencias Sociales	1	6
López-Huertas, MJ	2	12	Bibliodoc	1	6
Muñoz-Muñoz, AM	2	12	BID: Biblioteconomia y Documentació	1	6
Pino-Díaz, J	2	12	Boletín de la ANABAD	1	6
Rodríguez García, Gloria	2	12	Boletín Medes: Medicina en Español	1	6
Repiso Caballero, R	2	12	Brit Med J	1	6
Barriga, Omar A	1	6	CILIP Update	1	6
Bordons, M	1	6	Comunicar	1	6
Cobo, MJ	1	6	Educación Médica	1	6
Diego Carmona ML	1	6	Education for Information	1	6
Faba, C	1	6	Index de Enfermería	1	6
Fernández Cano, A	1	6	Information Research	1	6
Fernández, V	1	6	Int J Clin Hlth Psyc	1	6
Gacto Colorado, MJ	1	6	J Am Med Inform Assn	1	6
Guallar, J	1	6	J Doc	1	6
Herrera-Viedma, E	1	6	J Inf Sci	1	6
Liberatore, G	1	6	J Informetr	1	6
Marcos-Cartagena, D	1	6	J Nurs Scholarship	1	6
Mendoza-Parra, S	1	6	Libr Inform Sci Res	1	6
Moed, HF	1	6	Libri	1	6
Ortega, JM	1	6	Med Clin(Barc)	1	6
Osma Delatas, E	1	6	Nature	1	6
Paravic-Klijn, T	1	6	Nurs Res	1	6
Peis Redondo, E	1	6	Progresos de Obstetricia y Gine	1	6
Pérez Andrés, C	1	6	Psicothema	1	6
Poyatos Huertas, E	1	6	Psychology Science Quarterly	1	6
Roldán, A	1	6	Res Policy	1	6
Sanz Casado, E	1	6	Rev Esp Sanid Penit	1	6
Torres Ramírez, I	1	6	Rev Inves Iberoamericana Ciencia Inf Doc	1	6
			Rev Neurol	1	6
			Revista del Consejo General de Colegios de Odontólogos y Estomatólogos de España	1	6
			Revista Española de Enfermedades Digestivas	1	6
			The Lancet	1	6

Detection and Suppression of False Documents

The results were made public in May 29, 2012 in a working paper uploaded to the institutional repository of the University of Granada (Delgado López-Cózar, Robinson-García, & Torres-Salinas, 2012). Simultaneously, we announced our findings in the research group's blog (http://ec3noticias.blogspot.com.es/2012/05/manipular-google-scholar-citations-y.html). Two days after this happened, Google erased all traces from our false fictitious researcher Pantani-Contador as well as the GS Citations profiles of the authors of this article, which were kept in quarantine for some weeks without notifying the authors at any time and then cleaned and made publicly available.

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FIG. 4. Screenshot of the citations received by an article authored by Daniel Torres-Salinas and Emilio Delgado López-Cózar. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

However, the initial testing document, which was not reported in our working paper, still remained as cache although the PDF was no longer available on the web (see Figure 4), signifying that the suppression of Pantani-Contador and his papers was more of a reaction to our complaint than because GS had uncovered the deception. Weeks after the restitution of the authors' GS Citations profiles the false record was finally removed.

Discussion

The results of our experiment show how easy it is to modify the citation profiles offered by GS Citations, which also would indirectly affect GS Metrics. The ease with which citation data can be manipulated raises serious concerns about the use of GS and its by-products as research evaluation tools. Also, it shows that even though GS's susceptibility to citation manipulation had been previously pointed out (Labbé, 2010; Beel & Gipp, 2010), nothing has been done since with regard to GS Citations and GS Metrics. Although GS is only meant to index and retrieve all kinds of academic material in the widest sense (Meho & Yang, 2007), the inclusion of GS Citations and GS Metrics, which are evaluation tools, must include some filters and monitoring tools as well as the establishment of a set of more rigid criteria for indexing documents. Switching from a controlled environment where the output, dissemination, and evaluation of scientific knowledge is monitored to an environment that lacks any kind of control other than a researcher's conscience is a radical novelty that poses many dangers (Table 4).

TABLE 4. Control measures in the Web of Science versus GS Metrics and Citations.

Web of Science	Google Scholar
– Databases select journals to be indexed – Journals select papers to be published – There is a control between citing and cited documents – Fraudulent behaviours are persecuted	– It indexes any document belonging to an academic domain – Any indexed document type produces and receives citations – It is not possible to alert on fraudulent behaviors or citation errors

The growth of GS Metrics compared with other traditional journal rankings as well as the similarities in their results (Delgado López-Cózar & Cabezas-Clavijo, 2013) seems to validate it as a good alternative. Still, the metrics tool includes many methodological and technical errors (i.e., identification of citations, lack of transparency on coverage, lack of quality control) that make it an easy target for citation manipulation. The product is vulnerable if editors and researchers are tempted to do "citations engineering" and modify their h-index by excessively self-citing their papers. Indeed, as Bartneck and Kokkelmans (2011) proved, the h-index can be easily inflated by means of three possible strategies: random self-citation, recent self-citation, or, in the most refined way, sending citations only to the hot zone of their publications, that is, to those that can influence this indicator. Devious editors can easily modify their journals' h-index, having a significant effect especially for those

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journals with small figures on which the slightest variation can have a great impact on their ranking position.

When analyzing the effect of the manipulation on the indicators used by GS, that is, the h-index and the i10-index, we note that many of the weaknesses pointed out by others can be clearly observed (Costas & Bordons, 2007; Waltman & van Eck, 2012). In fact, the h-index seems quite stable when affecting experienced researchers whereas it can vary significantly when affecting young researchers (see Table 1). Hence, the variation of the h-index is influenced by researchers' previous performance, as pointed out by Waltman and van Eck (2012). As for the i10-index, it experiences the contrary effect, varying more significantly for experienced researchers.

Conclusion

In this article, we call attention to what we believe is the main shortcoming of GS Citations and Metrics: The ease with which they can be used to manipulate citation counting. For this we performed a basic and even coarse experiment, trying to bring as much attention to it as possible. We uploaded six false documents to an institutional domain authored by a fictitious researcher citing the scientific output of a research group. We also tried to draw as much attention as we could to it, uploading first a previous version of this article to a repository (Delgado López-Cózar et al., 2012) in order to nourish debate among the research community and social media. In this way, we demonstrated not only how easy it can be to manipulate citation counting in GS but also that anyone can do it, no matter how clumsy they are with technology. This means that if a more refined experiment had been done (i.e., sending citations only to those papers which would modify the h-index) it would also have gone unnoticed. Also, by using a fictitious researcher we highlight that excluding self-citations may not be sufficient to detect such abuses.

As suggested by many during the discussion after a previous version of this paper was made public (see, e.g., Davis, 2012), one cannot expect GS to develop tools to avoid fraud when this has not been accomplished by traditional citation indexes (Falagas & Alexiou, 2008; Opatrný, 2008). Nevertheless, their products should be as transparent as possible so that abuses can be easily detected. In this sense, the lack of response as well as the way in which Google proceeded is worrisome; it deleted the false documents to which it had been alerted without reporting to the affected authors, retaining the initial testing document along with its citations. This lack of transparency is the main obstacle when considering GS and its by-products for research evaluation purposes. It is essential not just to display the total number of citations and h-indexes of researchers, but to show which of them are self-citations, and the value of the h-index once these have been removed. This way we would be able to detect to what extent self-citations are affecting the impact of researchers and journals. Also, GS and its by-products should include filtering systems according to document type which would avoid effects such as those described in this article. Some of these measures would be easy to adopt, such as distinguishing according to document type (i.e., between journal articles, books, or patents) or sources from which these are retrieved (i.e., journals, repositories, or self-archiving).

However, one must acknowledge that the most efficient control or filters to avoid fraud or data manipulation are researchers' own ethical values. GS is contributing with GS Citations and GS Metrics to a democratization and popularization of research evaluation and hence cannot avoid the responsibility of eliminating the temptation to trick the metrics by means of transparency.

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