Research Trends

Research Trends Issue 39: Emerging indicators and standards for research assessment

After four years as Editor-in-Chief of Research Trends, Professor Henk Moed has decided to resign his duties.

During his tenure as Editor-in-Chief, Research Trends enjoyed the privilege of being guided and enriched by Henk. As a prestigious and well-acknowledged scholar in the bibliometrics community, Henk joined Elsevier as a senior scientific advisor and also took Research Trends under his wings. Under his supervision, Research Trends not only evolved in content but also in quality, becoming a respected publication followed by thousands, with several of its articles translated into different languages and cited regularly in peer reviewed journal articles. In addition to guiding the content and coverage of Research Trends, Henk also heavily contributed to each and every issue with thought-provoking research articles and analyses such as research evaluation approaches, new methods for regional and country level scientific output analysis, disciplinary and content analysis and many more. As Editor-in-Chief, Henk also broadened Research Trends' scope by including interviews with leading scientific figures, reporting back from conferences and events and publishing special issues on current topics such as Big Data and Altmetrics.

Beyond his obvious scientific and professional contributions to Research Trends as a growing publication, he always served as a mentor to those of us on the Editorial Board. Offering scientific advice on methodologies, research topics and approaches, he encouraged each of us to pursue research and writing and strive to produce better articles in each and every issue. We would like to thank Henk for his enormous contribution, support and guidance to all of us and the publication as a whole and wish him luck in his future endeavors.

The current issue of Research Trends is dedicated to new and evolving methods and approaches to capturing and evaluating research impact. A new metric that measures the internationalization of institutions, developed by Hans Pohl, Guillaume Warnan and Jeroen Baas, is described in their contribution. Comparing their newly developed field-weighted approach to measure internationalization to existing methods, the authors demonstrate how an institution's international collaboration can be more accurately captured.

Differences in funding foci and their influence on brain research in the USA and Europe are described by Georgin Lau and Dr. Judith Kamalski, demonstrating a new approach to funding data analysis using Elsevier fingerprinting technologies.

The topic of collaboration and scientific output is also discussed in George Lan's article on the Sub-Saharan region's scientific capacity. Adapted from a larger study conducted by the World Bank and Elsevier on the state of Science, Technology, Engineering, and Mathematics research in SSA (Sub-Saharan Africa), this article offers a look into the region's collaborations, research capacity and output.

Finally, the topic of implementing standards in research metrics was one of discussion and debate at the latest STI conference, held at Leiden University in September, which is reported on in this issue. A more in-depth examination of this topic is offered by Dr. Lisa Colledge and myself, including the opinions of leading researchers whom we interviewed.

We hope you will enjoy this issue. We welcome your comments and feedback on its contents.

Kind regards,

Gali Halevi

Research Trends

Section 1:
Behind the data

Level the playing field in scientific international collaboration with the use of a new indicator: Field-Weighted Internation-alization Score

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Introduction

International relations are and have always been inherent in higher education and research (1). However, internationalization of higher education institutions (HEIs) exhibits a growing trend, as illustrated by bibliometric data (2). Amongst other things, the internationalization trends challenge the leadership of the HEI and lead to changes in management structure (3).

An assessment of the internationalization impact has to be aligned with the core missions of the HEI (4) and there is a need to manage and measure various internationalization aspects:

"Without a clear set of rationales, followed by a set of objectives or policy statements, a plan or set of strategies, and a monitoring and evaluation system, the process of internationalization is often an ad hoc, reactive, and fragmented response to the overwhelming number of new international opportunities available" (5).

Common internationalization indicators include share of international students and staff, and share of international co-publications. Indicators of this type are widely used for comparisons, rankings such as QS World University Rankings and even for the allocation of funding to HEIs (6).

This paper addresses one clearly defined but rather crude indicator: the share of international co-publications (for a given researcher or institution). The indicator has several advantages, among them relatively unbiased data, the possibility to study all levels from individual researchers to countries and the ease of interpreting it. But there are also weaknesses. Comparisons of researchers, groups of researchers or even HEIs with different scientific profiles are difficult, as the typical share of international co-publications varies substantially between different scientific fields. This is illustrated in Figure 1, which also shows how the share of international co-publications has increased over time in all scientific fields.

Another weakness is that the share of international co-publications changes with different types of publications (see Table 1).

The aim of this paper is to develop and test an indicator that eliminates these weaknesses without losing the advantages. The indicator described in this piece, named the Field-Weighted Internationalization Score (FWIS), builds on the Field-Weighted Citation Impact (FWCI) calculation.

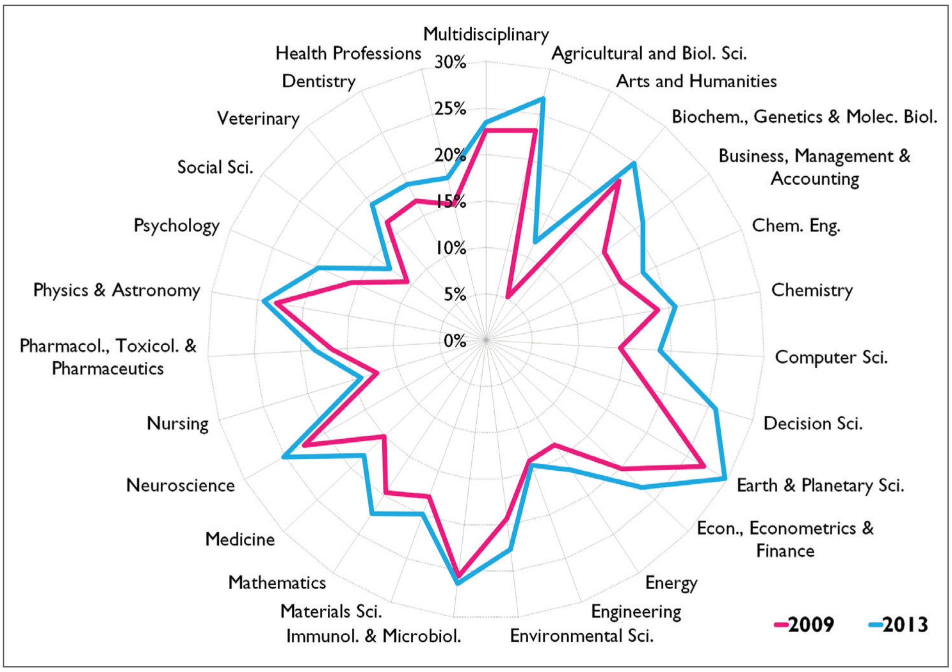

Figure 1: Share of international co-publications per scientific field 2009 and 2013. Source: Scopus

Scientific field	**Share of international co-publications**			
	All types	**Articles**	**Conference proceedings**	**Reviews**
Medicine	16.8%	18.8%	17.1%	17.7%
Chemistry	19.6%	20.9%	17.7%	19.3%
Social Sciences	12.0%	12.6%	12.4%	8.3%
Global	18.2%	20.2%	14,9%	17.5%

Table 1: International co-publications per publication type overall and for 3 different scientific fields, 2013

Publication	**China**	**USA**	**UK**	**International?**
#1	1			0 (no)
#2		1		0 (no)
#3		1	1	1 (yes)
#4	1	1	1	1 (yes)

Table 2: First example with 4 publications and 3 countries

Theoretical framework

While many articles study the concept of scholarly collaboration (7) or point out the importance of international collaboration (8), the assessment of international collaboration remains a more limited field of study. It really became a subject of interest in the 1990s (9-11). Indexes were created (12), but never aimed at comparing institutions or research entities with one another.

The FWIS is calculated using the same base-normalization as is applied in the calculation of the Field-Weighted Citation Impact (13). This in turn is based on the scientific consensus reached recently (14), after criticism that normalization scores should be calculated at the publication level (15) and the contributing counts need to be fractionalized (16). In essence, this means that each publication will have a calculated expected value, normalized for publication year, document type, and field. The FWCI score for each publication is the actual value divided by the expected value.

FWIS Methodology

The same logic is used for the calculation of the FWIS, and instead of citation counts, a simple binary indication of the presence of collaboration on the publication is included. Citation counts behave a little different, as a publication can be cited for instance twice as much as another publication. The simple binary indication of an international co-publication recognizes only two states: either the publication is internationally co-authored (value is 1), or the publication is not (value is 0). This calculation therefore relates to the percentage of internationally co-authored publications, rather than the average internationality of publications (where FWCI does relate to the average number of citations per publication).

In order to overcome the pitfall of measuring collaboration rates against a global rate – when most entities will appear to achieve collaboration rates that are higher than expected – the expected value of collaboration per publication is calculated by weighting the publications by the number of countries that appear on the publication.

To illustrate the methodology with an example (see Table 2 - we will first assume all documents are from the same year, document type and subject, and gradually add complexity to the example to fully understand the calculations): suppose we have a total of 4 publications in our database, which includes 3 different countries: China, USA and UK. The global share of international co-publications is 50% as 2 out of 4 are internationally co-authored.

In our example, China has 50% international publications, USA has 67% and UK 100%. If you were to compare these percentages to the global average, it would appear as if all of these are above or exactly at the global average. To remedy this effect in collaboration, we multiply the weight of publications by the number of collaborating countries contributing to the publication. In our example, that would mean a global average of (1*0+1*0+2*1+3*1)/(1+1+2+3)=71% and not 50%.

Multiplying by number of countries on a publication means that the percentage of internationally co-authored publications is affected by the average number of countries on a publication. When comparing values that have been calculated for different fields (and thus having different average number of countries per publication) this indirectly causes different results. If for instance in a field, without multiplying by country, a group of researchers have 30% international co-publications vs. a global average of 15% (twice as high), and in another field the same group has 10% international collaboration vs. a global average of 5% (also twice as high), it may be that the FWIS derived from those publications per field is different if the average number of countries on international publications is different. The rationale of this difference is that fields with more countries per publication have a higher likelihood of international collaboration.

Publication	China	USA	UK	Count of countries	International?	Expected score per publication	FWIS
#1	1			1	0 (no)	0.71	0
#2		1		1	0 (no)	0.71	0
#3		1	1	2	1 (yes)	0.71	1.41
#4	1	1	1	3	1 (yes)	0.71	1.41

Table 3: Addition of the count of countries and FWIS taking into account the number of countries

Publication	China	USA	UK	Count of countries	Subject classification
#1	1			1	A
#2		1		1	B
#3		1	1	2	B, C
#4	1	1	1	3	A, C

Table 4: Addition of subject classifications

Publication	China	USA	UK	Count of countries	Subject classification	International	Expected score per publication	FWIS
#1	1			1	A	0 (no)	0.6	0
#2		1		1	B	0 (no)	0.5	0
#3		1	1	2	B, C	1 (yes)	0.67	1.5
#4	1	1	1	3	A, C	1 (yes)	0.75	1.33

Table 5: Addition of the FWIS per publication taking into account the number of countries and the subject classification

FWIS uses a publication-oriented approach, which means that an expected and actual value for each publication is calculated. The expected count is derived by taking the total number of international co-publications divided by the total number of publications, and by weighting these counts with the number of countries involved. This would mean in our example (see Table 3): (1*0+1*0+2*1+3*1)/(1+1+2+3)=0.71. The FWIS for each publication is derived by dividing the actual value (0 or 1) by the expected value.

In order to calculate the score for an entity (entity could for example be a country, institution or group of researchers), we simply take the arithmetic mean of each FWIS score for the entity's publications. For instance, for China this would be: (0+1.41)/2=0.71.

When calculating the global score for the entire dataset – as is required to validate the calculation and end up with a score of 1.00 – each publication again needs to be weighted, using the count of countries that are present on the publication. In our example, the global value is derived by: (0*1+0*1+1.41*2+1.41*3)/(1+1+2+3)= 1.00. The same weighting is required when calculating the score for entities that span multiple countries. For instance, for a continent, the value is derived by multiplying the score for each country that is part of that continent.

To fully understand the model, we also need to consider the properties from FWCI that have remained the same: normalization by subject, publication type and year. Normalizing publication types and year of publication are relatively straightforward, by simply taking the average international rate within each subgroup (for example, 2008 and reviews). Subjects are a little more complicated, because publications can belong to multiple subjects at the same time.

Let's take a look at our initial example, and this time adding subject classifications to the publications (see Table 4).

In order to account for which subject a publication belongs to, and thus to calculate the expected value per subject, each publication is weighted to the subject by fractionalizing the publication. For publication #3, this means that 50% of the publication counts towards subject B and 50% to subject C. For each subject, the expected value is therefore in this example (multiplying by country-count and fractional subjects):

Subject A: (1*1*0 + 3*0.5*1)/(1*1+3*0.5)=0.6
Subject B: (1*1*0 + 2*0.5*1)/(1*1+2*0.5)=0.5
Subject C: (2*0.5*1 + 3*0.5*1)/(2*0.5+3*0.5)=1.0

To form the expected counts using each of these normalized scores, we take the harmonic mean of the subjects per publication (see Table 5). For publication #3 this is 2/((1/0.5)+(1/1))=0.67, and for publication #4 this is 2/((1/0.6)+(1/1))=0.75. The FWIS per publication again is derived by dividing International (1 or 0) by the expected score.

In this example, the FWIS for China is (0+1.33)/2=0.66. To validate the model, the global average still needs to be 1.0 across the subject fields. Applying the same country-count weighting as before, this is calculated as (0*1+0*1+1.5*2+1.33*3)/(1+1+2+3)=1.0.

Testing the new metric

The FWIS was recently tested on a real-case example. In collaboration with the Swedish Foundation for International Cooperation in Research and Higher Education (STINT), we compared 28 Swedish universities on the basis of their level of internationalization.

A first analysis was based on the share of international co-publications (see Figure 2 – right part). That analysis put forward institutions focused on disciplines where international collaboration is naturally strong such as Economics, Econometrics and Finance (Stockholm School of Economics) or Life Sciences (Stockholm University).

A second analysis used the FWIS (see Figure 2 – left part), and both rankings were finally compared (see Figure 3).

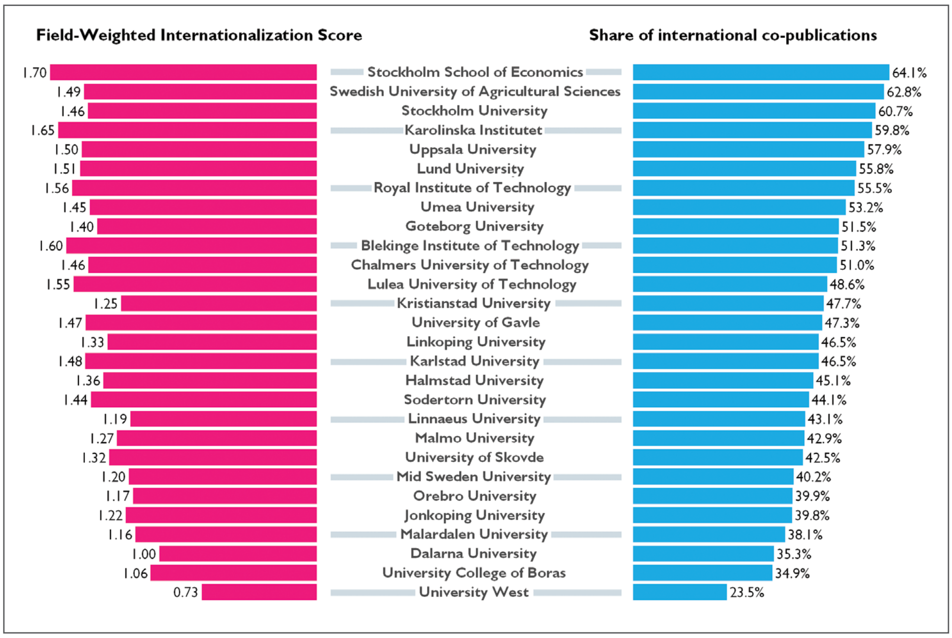

Figure 2: FWIS and share of international co-publications per Swedish university – 2013. Source: SciVal and Scopus.

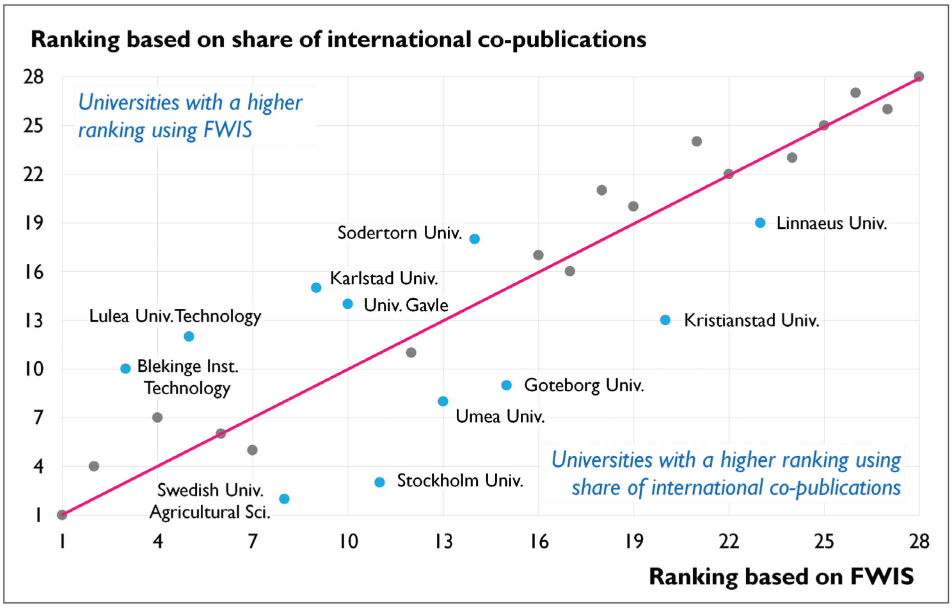

Figure 3: Comparison of the ranking of Swedish universities based on the share of international co-publications or FWIS – 2013. Source: SciVal and Scopus. Note: This Figure was updated on 21 November 2014 to correct the placement of the blue captions.

40% of the institutions (11 out of 28) experienced a major change (greater than four places) in their ranking position due to the change of indicator used as a basis for the ranking.

The example of Luleå University of Technology is very representative of the impact of the use of the FWIS instead of the share of international co-publications. Luleå focuses predominantly on engineering-type disciplines (see Figure 4) which are typically quite weak in terms of international collaboration (see Figure 1).

Luleå's share of international co-publications in those disciplines may appear limited (around 50%), but they are much greater than the global average (see Table 6). When changing from a ranking based on share of international co-publications to one based on FWIS, Luleå moves up 7 positions.

The FWIS indicator gives Luleå University of Technology a better value as it takes the specific mix of the university's scientific fields into account, i.e. the output of Luleå is compared fairly with that of peers instead of assuming that all universities have the same mix of scientific production.

Conclusions

Responding to the need for better management and understanding of internationalization of research and higher education, this paper elaborates and tests a new indicator relating to international research collaboration. The proposed FWIS indicator is argued to enhance the possibilities to measure and compare internationalization of HEIs. The very common indicator using the share of international co-publications includes biases due to scientific profile, type of publication and year of publication. Using a method similar to the calculation of FWCI, the proposed indicator eliminates these biases with the same underlying dataset.

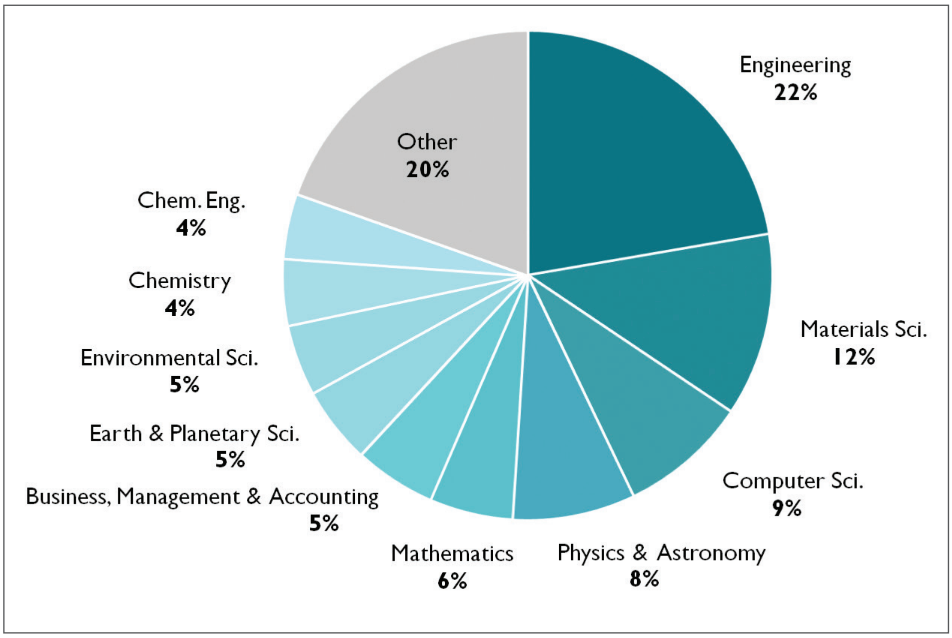

Figure 4: Split of publication output per journal category for Luleå University of Technology – 2013. Source: SciVal .

Discipline	Share of international co-publications		FWIS
Level of analysis	Global	Luleå University of Technology	Luleå University of Technology
Engineering	14.3%	49.2%	1.90
Materials Science	19.9%	57.6%	1.84
Computer Science	18.8%	50.9%	1.73

Table 6: Share of international co-publications and FWC for a selected number of disciplines – 2013. Source: SciVal and Scopus.

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Section 2:
Research Trends

Brain research: Mining emerging trends and top research concepts

Georgin Lau & Dr. Judith Kamalski

Like the brain itself, brain research is complex and encompasses the study of Brain Anatomy, Neuroscience, Cognitive Science, and interrelated disciplines. Disciplinary silos are breaking down, with investigators from fields including Medicine, Biology, Engineering, Computer Science, and Psychology working within large collaborative research initiatives. The growing interest in new ways to treat or even prevent brain disorders, as well as the push towards cross-disciplinary research, provides context for a recently launched Brain Research Report (1) that offers an overview of the state of research in the area of Brain and Neuroscience. This report was discussed at Neuroscience 2014, the Society for Neuroscience's Annual Meeting, taking place in November in Washington, DC. Beyond understanding the publication output, growth and impact of key countries in Brain and Neuroscience research, new methodologies were experimented with to mine for emerging trends in this field, and to discern different research emphasis between funded grant awards and existing Brain and Neuroscience publications.

Brain research is Neuroscience and more

The document sets underlying our analyses were created using text mining and natural language processing techniques inherent in the semantic Elsevier Fingerprint Engine™. Our approach to define Brain and Neuroscience is multi-method and iterative, and relies on both automatic and manual input to select relevant articles for analysis. By combining three approaches – an initial journal-based classification system, semantic fingerprinting using the Fingerprint Engine, and internal and external expert review and selection of key concepts – we were able to identify a broad set of articles that best represent the entire field of Brain and Neuroscience research. For example, our document set comprised about 91% of all articles in the Neuroscience journal category in 2009-2013, and 64% of the articles in the Psychology journal category in Scopus (see Figure 1). Figure 2 shows the concepts where the selection rate was 100%, meaning that all documents that contained these concepts were included.

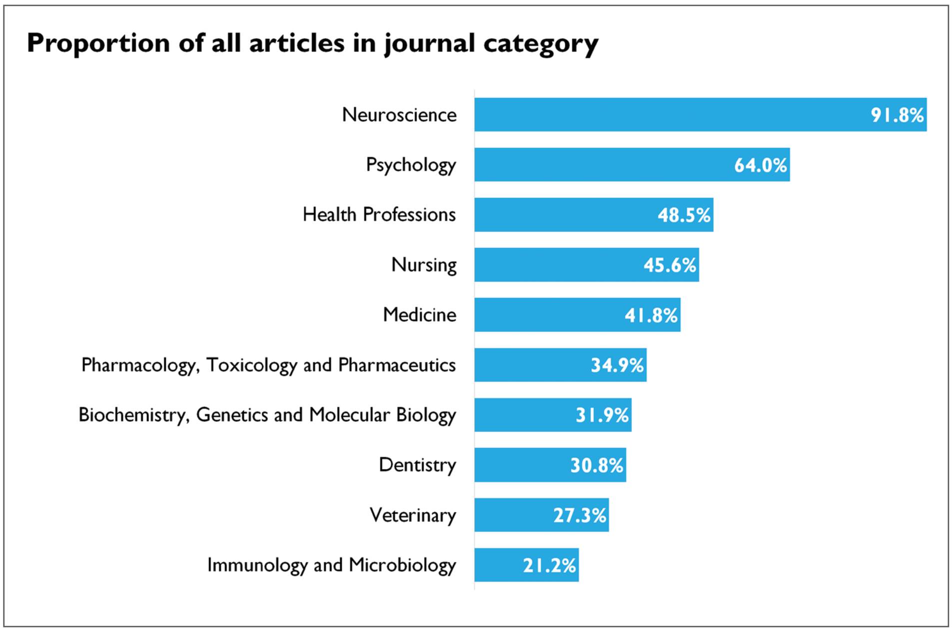

Figure 1: Selected articles were not only from the Neuroscience journal category in Scopus, but also other related journal categories. The top 10 journal categories are shown in this figure, along with the proportion of all documents in each journal category which were included in our selected document set. Source: Scopus

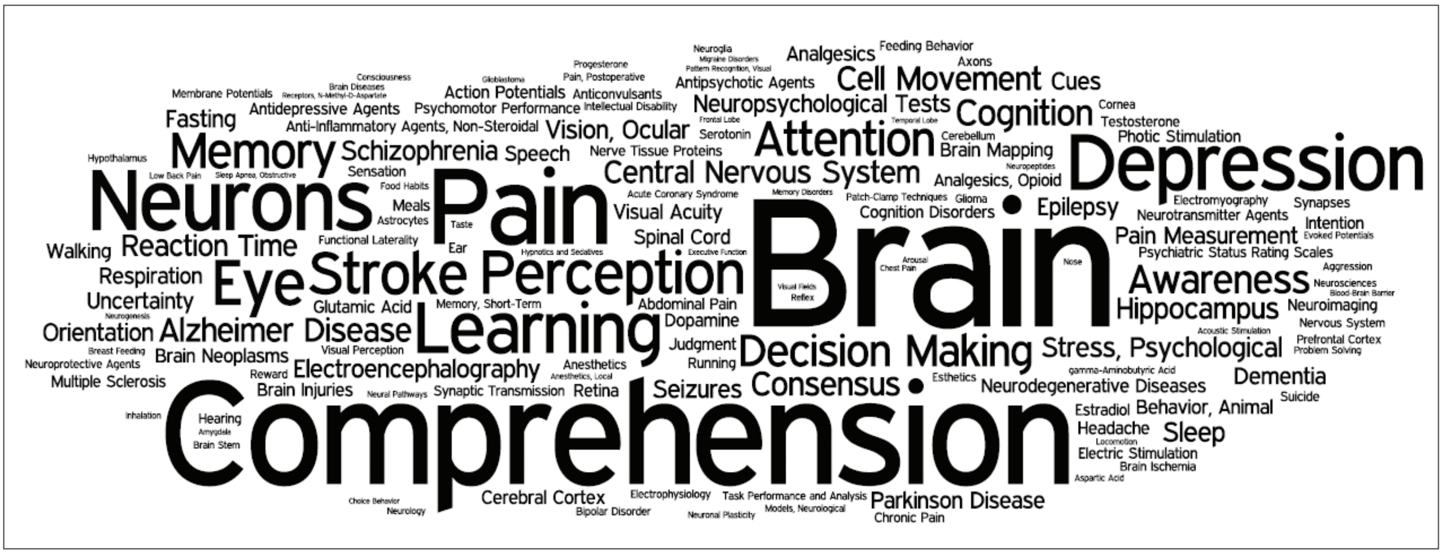

Figure 2: Concepts from selected document set where the selection rate was 100%, meaning that all relevant documents that contained these concepts were included in our analysis. The size of each concept is weighted by the number of occurrences in the selected document set. Source: Scopus

Emerging trends

Trends and correlations can provide insight into how topics of interest emerge from research outputs; however, the challenge remains to differentiate obvious trends from those that are emergent: one approach is to compute them using big data, and then have the results validated by experienced practitioners and scientists of the field. The burst detection algorithm proposed by Kleinberg (2) provides a model for the robust and efficient identification of word bursts, and allows the identification of rapid growth within categories or thesauri. By applying the burst detection algorithm, we were able to find concepts which displayed rapid growth over the years, signaling a "burst of activity". Compared to the period 2003-2008, both broad and specific Brain and Neuroscience concepts grew rapidly in 2009-2013. These include concepts such as "High-throughput Nucleotide Sequencing," "Molecular Targeted Therapy," "Molecular Docking Simulation," "Sirtuin 1," "Purinergic P2X Receptor Antagonists" and "Anti-N-Methyl-D-Aspartate Receptor Encephalitis."

Top concepts in published Brain and Neuroscience research were organized by overall theme (semantic group). Under the disorders group, concepts such as "Stroke," "Depression," "Neoplasms," and "Alzheimer Disease" were seen most often, while under anatomy, "Brain," "Eye," and "Neurons" were most common (see Table 1).

Different research emphasis in the EU and the US

Next, we compared the top concepts within the Brain and Neuroscience research publications from Scopus against publications produced by the recipients of funded grant awards related to Brain and Neuroscience research from the National Institutes of Health (NIH) (3), and project abstracts that were available from the list of brain research projects supported by the European Commission (EC) (4). Concepts were extracted from about 2 million Brain and Neuroscience articles from Scopus, 59,637 articles produced by recipients of funded grant awards relating to Brain and Neuroscience research from NIH, and 136 project abstracts available from the Brain research projects supported by the EC. As expected, concepts such as "Brain," "Neurons," "Seizures," and "Brain Neoplasms" were seen with similar frequency in the published articles and the NIH-funded grant abstracts. However, concepts such as "Eye," "Pain," and "Stress, Psychological" were more highly represented in published articles than in NIH-funded abstracts, suggesting a divergence from funding to publication.

Not surprisingly, NIH-funded abstracts more often contained disease-related concepts, consistent with the NIH's focus on areas of research with perceived high societal impact. Compared to the research funded by the EC, US research focused on the concepts "Glioma," "Child Development Disorders, Pervasive," and "Bipolar Disorder." Conversely, concepts such as "Memory Disorders," "Vision Disorders," "Myasthenia Gravis," "Hearing Loss," and "Alkalosis" were more frequent in the EC-funded research compared to the US, suggesting a different emphasis in research relating to disorders in Brain and Neuroscience (see Table 2). In the US, drugs related to substance abuse were highly researched, with the appearance of concepts such as "Methamphetamine," "Nicotine," and "Cannabis." In contrast, antipsychotic drugs such as "Risperidone" and "Clozapine" that are mainly used to treat schizophrenia were areas of focus in the EC-funded research (see Table 3).

Activities & Behaviors	Anatomy	Chemicals & Drugs	Disorders	Genes & Molecular Sequences
Exercise (12,473)	Eye (14,836)	Proteins (12,255)	Stroke (21,404)	Single Nucleotide Polymorphism (4,007)
Suicide (6,106)	Neurons (14,388)	Glucose (7,423)	Depression (21,668)	Alleles (3,248)
Motor Activity (6,454)	Cells (15,167)	Food (8,477)	Neoplasms (25,047)	Genome (2,742)
Speech (8,055)	Muscles (10,758)	Alcohols (6,396)	Alzheimer Disease (14,522)	Quantitative Trait Loci (590)
Behavior (11,274)	Stem Cells (7,034)	Insulin (6,021)	Pain (16,719)	Major Histocompatibility Complex (450)
Smoking (4,667)	Brain (15,980)	MicroRNAs (4,180)	Schizophrenia (13,752)	Homeobox Genes (449)
Costs and Cost Analysis (6,437)	T-Lymphocytes (6,261)	Pharmaceutical Preparations (10,822)	Parkinson Disease (11,366)	Catalytic Domain (811)
Residence Characteristics (7,277)	Bone and Bones (7,257)	Peptides (6,718)	Wounds and Injuries (13,414)	Transcriptome (777)
Walking (5,517)	Spermatozoa (3,944)	Acids (5,225)	Syndrome (13,258)	Transgenes (513)
Work (7,139)	Face (5,974)	Cocaine (3,153)	Multiple Sclerosis (9,275)	Oncogenes (394)

Table 1: Top 10 concepts that occurred in Brain and Neuroscience research articles from Scopus between 2008 and 2013, based on the semantic groups to which they belong, sorted by the sum of term frequency-inverse document frequency (tf-idf) of the concept in the document set, where the tf-idf value reflects the relevance and importance of the concept in the document. Figures in parentheses are the frequency with which the concept occurred in the set of Brain and Neuroscience research articles from Scopus between 2008 and 2013 (i.e. the tf value). Source: Scopus

Top 10 concepts relating to disorders in:		
Set A - Brain and Neuroscience articles from Scopus	**Set B - Brain and Neuroscience funded grant awards from the NIH**	**Set C - Brain research project synopses supported by the European Commission**
Stroke (21,404)	Alzheimer Disease (842)	Stroke (6)
Depression (21,668)	Stroke (328,070)	Parkinson Disease (7)
Neoplasms (25,047)	Schizophrenia (19,489)	Schizophrenia (5)
Alzheimer Disease (14,522)	Pain (15,742)	Memory Disorders (3)
Pain (16,719)	Parkinson Disease (15,963)	Vision Disorders (2)
Schizophrenia (13,752)	Depression (6,028)	Alzheimer Disease (4)
Parkinson Disease (11,366)	Neoplasms (14,585)	Myasthenia Gravis (1)
Wounds and Injuries (13,414)	Glioma (9,271)	Hearing Loss (3)
Syndrome (13,258)	Child Development Disorders, Pervasive (4,062)	Alkalosis (1)
Multiple Sclerosis (9,275)	Bipolar Disorder (2,571)	Pain (1)

Table 2: Top 10 concepts that occurred in Brain and Neuroscience research articles relating to disorders from document sets A, B and C, based on the sum of term frequency-inverse document frequency (tf-idf) of the concept in the document set that it belonged to. Figures in parentheses are the frequency with which the concept occurred in the document set. Highlighted in grey are concepts that appeared in the top 10 disorder-related concepts in all three document sets, reflecting common areas of focus. Highlighted in orange are concepts that only appeared in Set A and Set B. Concepts that are not highlighted were those unique to each document set, indicating different areas of focus in disorder-related concepts in Brain and Neuroscience research.

Top 10 concepts relating to chemicals & drugs in:		
Set A - Brain and Neuroscience articles from Scopus	**Set B – Brain and Neuroscience output from funded grant awards from the NIH**	**Set C – Brain research project synopses supported by the European Commission**
Proteins (12,255)	Alcohols (663)	Enzymes (2)
Glucose (7,423)	Cocaine (4,670)	NADPH Oxidase (1)
Food (8,477)	Ethanol (653)	Inflammation Mediators (1)
Alcohols (6,396)	Methamphetamine (13,551)	Anticonvulsants (2)
Insulin (6,021)	Analgesics, Opioid (1,068)	Quantum Dots (1)
MicroRNAs (4,180)	Nicotine (14,836)	Iron (1)
Pharmaceutical Preparations (10,822)	MicroRNAs (407,989)	Peptides (1)
Peptides (6,718)	Dopamine (6,756)	Risperidone (1)
Acids (5,225)	Cannabis (3,270)	Clozapine (1)
Cocaine (3,153)	Prions (17,586)	Phosphotransferases (2)

Table 3: Top 10 concepts that occurred in Brain and Neuroscience research articles relating to chemicals & drugs from document sets A, B and C, based on the sum of term frequency-inverse document frequency (tf-idf) of the concept in the document set that it belonged to. Figures in parentheses are the frequency at which the concept occurred in the document set. Highlighted in orange are concepts that only appeared in Set A and Set B. Highlighted in grey are concepts that only appeared in Set A and Set C. Concepts that are not highlighted were those unique to each document set, indicating different areas of focus in chemicals & drugs-related concepts in Brain and Neuroscience research.

Conclusion

The hidden complexities of the brain are being explored by scientists working across boundaries and across disciplines to overcome technological challenges and to develop new techniques, methods, and better equipment to study the brain. In our study of the top concepts in funded grant awards, research is driven towards a better understanding of diseases and disorders related to Brain and Neuroscience, such as autism and Alzheimer Disease. This is coupled with an emphasis on drug development, for instance in the area of schizophrenia treatment. Strong research is also evident in the area of genes and molecular sequences where concepts such as connectome and transcriptome have either been detected as having rapid growth or are already considered important concepts in Brain and Neuroscience research publications.

By providing the first attempt to understand the overall state of research in Brain and Neuroscience, the report reveals patterns of activities globally, which we hope will be useful to policy makers and decision makers in steering future strategy in Brain research.

There is also potential to conduct a deeper analysis of research in specific semantic groups of Brain and Neuroscience research, for example, focusing only on disorders, or chemical and drugs related publications and concepts.

Exploring the brain is akin to exploring the mind and exploring the self. Thus it is with great interest and anticipation that we watch for further developments in this important field of science, which will certainly affect us in one way or another as we learn more about our own brains.

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Section 3:

Country Trends

Building research capacity in Sub-Saharan Africa through inter-regional collaboration

George Lan

Over the next few decades, Sub-Saharan Africa (SSA) will benefit from a "demographic dividend" – a dramatic increase in its working-age population (1). Yet, increasing the subcontinent's labor pool cannot push Africa toward a developed, knowledge-based society without simultaneously increasing the subcontinent's capacity to train and educate that talent.

The strength of a region's research enterprise is closely correlated with that region's long-term development and important drivers of economic success. Research suggests that bibliometric indicators on publications can help characterize the stage of a country's scientific development (2).

A recent study conducted by the World Bank and Elsevier looked at the state of Science, Technology, Engineering, and Mathematics research in SSA (3). For this analysis, Sub-Saharan Africa is divided into three regions (West & Central Africa, Southern Africa, and East Africa). The country of South Africa is considered separately and independently from Sub-Saharan Africa due to large differences in research capacity and output between the two.

By many measures, SSA has made great strides in its research performance, doubling its overall research output over the past decade and significantly increasing its global article share (4). However, as past studies show, article growth in other countries and regions in the developing world – particular Asia – outpaced that of SSA in recent years (5).

Moreover, SSA researchers collaborate extensively with international colleagues. Between 2003 and 2012, international collaborations as a percentage of Southern Africa's total article output increased from 60.7% to 79.1% (Note 1). For Eastern Africa, international collaborations consistently comprised between 65% and 71% of the region's total output. Although West & Central African researchers collaborate with international colleagues at relatively lower levels (between 40% and 50% of its total research output came from international collaborations), those rates are still well above the world average.

However, echoing the findings of past studies (6), collaboration between different African regions remains low. To calculate the number of collaborations between East Africa and West & Central Africa, for example, we counted all publications in which at least one author holds an affiliation to an East African institution and another author holds an affiliation to a West & Central African institution. As Figure 1 shows, inter-regional collaborations constitute a small fraction of Sub-Saharan Africa's total international collaborations. In 2012, less than 6% of the region's total output resulted from inter-regional collaborations, while nearly 60% came from international collaborations. Moreover, more than half of those inter-regional collaborations were co-authored with colleagues from institutions in OECD countries (Note 2).

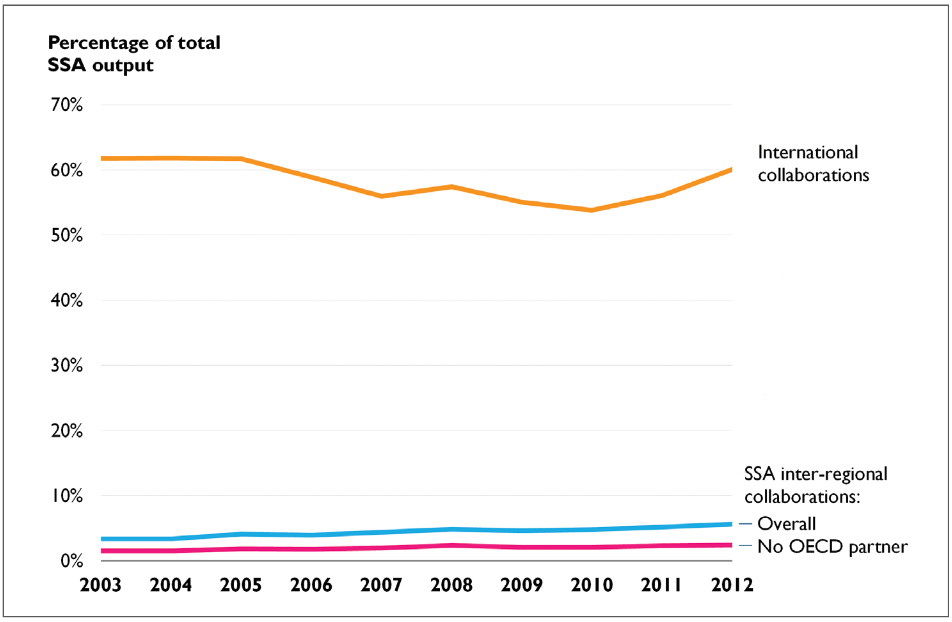

Figure 1: International and Inter-regional collaborations as percentage of Sub-Saharan African total research output, 2003-2012. Source: Scopus

Figure 2 displays the trends of inter-regional collaboration for specifically East Africa vis-à-vis the other regions and South Africa. The top three trend lines (those with stronger lines) correspond to all collaborations between East Africa (EA) and West & Central Africa (WC), Southern Africa (SA), and South Africa (ZA) respectively. The bottom three trend lines correspond specifically to collaborations in which no co-authors were affiliated with institutions in OECD countries.

Relative to East Africa's overall rates of international collaboration (which comprise over 60% of East Africa's total output), its level of inter-regional collaboration with other SSA regions is low, at about 2%. East Africa's collaborations with South Africa have increased considerably over time, from 3.9% in 2003 to 7.9% in 2012. This growth has been driven mostly through collaborations involving partners at institutions in developed countries. The annual growth rate of East Africa-South Africa collaborations with an additional OECD partner was 8.2%, compared to 3.3% for those collaborations without an OECD partner.

These patterns of low inter-regional collaboration rates (especially without another OECD country as a partner) hold for West & Central Africa as well. In 2012, collaborations between West & Central Africa and other SSA regions accounted for only 0.9% of the former's total research output.

Overall, the level of inter-regional collaborations in Sub-Saharan Africa has increased over the past decade, and this has been largely driven by collaborations involving OECD countries. On the one hand, this is welcome news, bolstering the subcontinent's research capacity. On the other hand, in order for the regions to further develop, there needs to be a greater focus on Africa-centric collaboration.

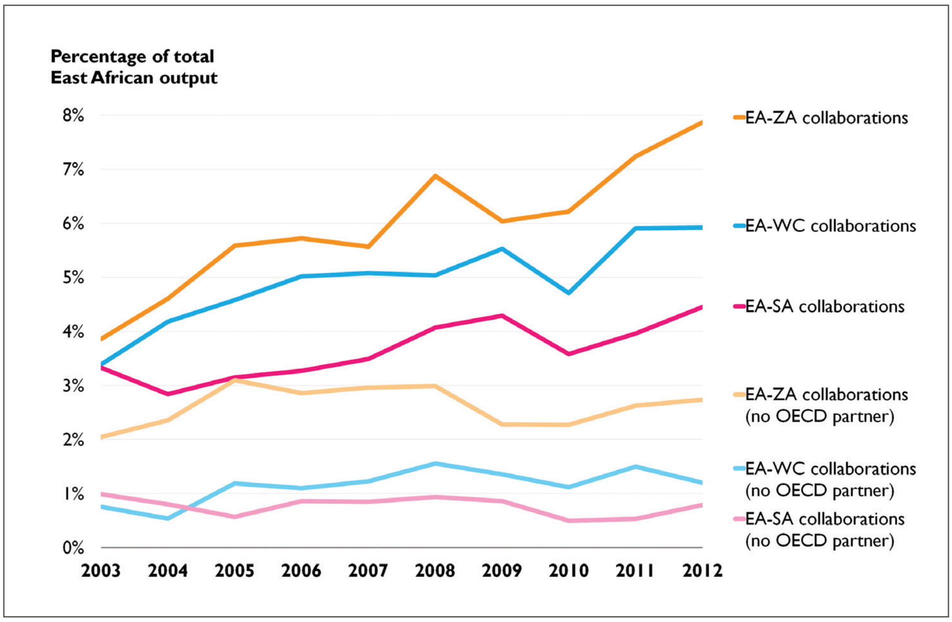

Figure 2: Different types of inter-regional collaborations as percentage of East Africa's total research output, 2003-2012. (EA = East Africa, WC = West & Central Africa, SA = Southern Africa, and ZA = South Africa). Source: Scopus

Notes

1. NB: this analysis defines international collaboration as multi-authored research outputs with authors affiliated with institutions in at least one region in SSA (West & Central Africa, Southern Africa, or East Africa) and elsewhere (including another SSA region).

2. OECD member countries include: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

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Section 4:
Reporting Back

Reporting Back: STI 2014, Leiden, The Netherlands

Dr. Gali Halevi

One of the main attractions at the Science and Technology Indicators (STI) conference (1) held in Leiden in September 2014, was "The Daily Issue". Invented by Diana Wildschut, Harmen Zijp and Patrick Nederkoorn, the reporters had three hours to find out what was happening at the conference and report about it using 1950s equipment and without telephones or internet (2). The result was a hilarious newsletter published every day and handed to the audience who came to realize how the world of Scientometrics looks to outsiders. An example included an item on the issue of serendipity in scientific process which resulted in the invention of "Serendipimetry", a metrics that measures serendipity (see additional interpretation in the side bar).

Alongside the traditional topics often discussed at the STI conference such as statistical representation of scientific output in forms of performance indicators and metrics, this year the conference put a strong focus on innovation. New datasets and algorithms were among the topics given significant attention. Examples include new data derived from funding systems which were explored in relation to productivity, efficiency, and patenting. Looking at the factors that influence participation in government funded programs, Lepori et al. (3) found a very strong concentration of participations from a very small number of European research universities. They also showed that these numbers can be predicted with high precision from organizational characteristics and, especially, size and international reputation. Relationships between funding, competitiveness and performance (4) were found to contradict previous findings, whereas here the researchers found that the share of institutional funding does not correlate with competitiveness, overall performance, and top performance. Additional research papers using funding systems data are available here.

SERENDIPIMETRY

(The Daily Issue; No. 72

http://sti2014.cwts.nl/download/f-z2r2.pdf)

Some of the most valuable scientific outcomes are the result of accidental discoveries.

This article explores the possibility of a metrics of serendipity.

Firstly, a clear distinction has to be made between a serendipity indicator and a serendipitous indicator.

The latter may only be meaningful in the way it could assist chance events in finding information.

More interesting however, it could be to actually measure, or at least estimate, the degree of serendipity that led to a research result.

And yet another angle would be the presentation of research that might facilitate its receivers, e.g. the readers of an article, in making odd detours, living through paradigm shifts et cetera.

New gender and career data currently available brought forth a series of studies dedicated to the relationship between gender, career level and scientific output. Van der Weijden and Calero Medina (5) studied the oeuvres of female and male scientists in academic publishing using bibliometrics. Using data from the ACUMEN survey (6), their analysis confirmed the traditional gender pattern: men produce on average a higher number of publications compared to women, regardless of their academic position and research field, and women are not evenly represented across authorship positions. Paul-Hus et al. (7) studied the place of women in the Russian scientific research system in various disciplines and how this position has evolved during the last forty years. They found that gender parity is far from being achieved and that women remain underrepresented in terms of their relative contribution to scientific output across disciplines. Sugimoto et al. (8) presented a study featuring a global analysis of women in patents from 1976 to 2013, which found that women's contribution to patenting remains even lower than would be predicted given their representation in Science, Technology, Engineering, and Mathematics.

Career-related studies also open new paths to understanding the relationships between academic positions, publishing, and relative scientific contributions of researchers throughout their careers. Derycke et al. (9) studied the factors influencing PhD students' scientific productivity and found that scientific discipline, phase of the PhD process, funding situation, family situation, and organizational culture within the research team are important factors predicting the number of publications. Van der Weijden (10) used a survey to study PhD students' perceptions of career perspectives in academic R&D, non-academic R&D, and outside R&D, and assessed to what extent these career perspectives influence their job choice. She found that several career-related aspects, such as long-term career perspectives and the availability of permanent positions, are judged much more negatively for the academic R&D sector.

A session on University-Industry collaborations featured interesting research topics such as the relationship between industry-academia co-authorships and their influence on academic commercialization output (Wong & Singh (11); Yegros-Yegros et al. (12)) as well as global trends in University-Industry relationships using affiliation analysis of dual publications (Yegros-Yegros & Tijssen (13)). Related to this topic was a session on patents analysis which was used to study topics such as scientific evaluation and strategic priorities (Ping Ho & Wong (14)).

Measures of online attention, a topic of discussion in the past couple of years, was given special focus at the conference with probably the most studies featured in a session. Studies covered topics such as Mendeley readership analysis and their relationship with academic status (Zahedi et al (15)), Tweets on the Nobel Prize awards and their impact (Levitt & Thelwall (16)), and gender biases (Bar-Ilan & Van der Weijden (17)).

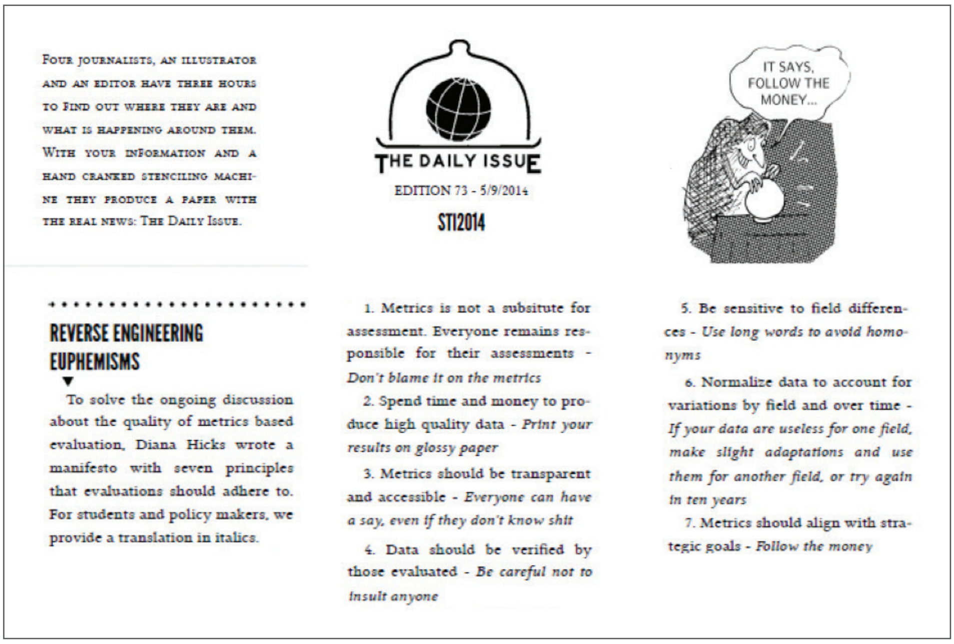
True to its slogan "Context counts: Pathways to master big and little data", this conference selected a wide range of studies using newly available data to explore topics that provide context to scientific output, including gender, career, university-industry and measurement of engagement. In addition, the selected keynote lectures provided some overall strategic insight into metrics development. Diana Hicks and Henk Moed encouraged the audience to think more strategically about the application of metrics for evaluation purposes. The 7 principles manifesto suggested by Diana Hicks provides evaluators with a framework which can be used to perform assessments of researchers, institutions and programs. This manifesto was picked up by the CWTS group in Leiden headed by Paul Wouters, who is now working on creating an agreed upon set of principles that could potentially inform evaluation and funding systems (18).

Henk Moed (19) called for special attention to be given to the context and purpose of evaluation, using meta-analysis to inform the choice of data and methodology of the evaluation. Presenting the "The multi-dimensional research assessment matrix", he gave some examples of how to compile correct and fair evaluation indicators using guiding questions that inform the process (20).

If there is one message that could be drawn from this conference it is that the plethora of recently available data, statistical analysis and indicators is an overall positive development only if they are used in the correct context and are able to answer the questions posed. There is no one metric that fits all evaluation objectives and therefore the data selected, the method used and the conclusions drawn must be made carefully, keeping in mind that context is probably the key factor to successful assessment.

The Daily Issue | Edition 73 commenting on Diana Hick's 7 principles of research evaluation manifesto

1. Metrics are not a substitute for assessment – Don't blame it on the metrics
2. Spend time and money to produce high quality data – Print your results on glossy paper
3. Metrics should be transparent and accessible – Everyone can have a say even if they don't know s***
4. Data should be verified by those evaluated – Be careful not to insult anyone
5. Be sensitive to field differences – Use long words to avoid homonyms
6. Normalize data to account for variations by fields and over time – If your data is useless for one field, make slight adaptations and use them for another field or try again in 10 years
7. Metrics should align with strategic goals – Follow the money



Four journalists, an illustrator and an editor have three hours to find out where they are and what is happening around them. With your information and a hand cranked stenciling machine they produce a paper with the real news: The Daily Issue.

THE DAILY ISSUE

EDITION 73 - 5/9/2014

STI2014

IT SAYS, FOLLOW THE MONEY...

REVERSE ENGINEERING EUPHEMISMS

To solve the ongoing discussion about the quality of metrics based evaluation, Diana Hicks wrote a manifesto with seven principles that evaluations should adhere to. For students and policy makers, we provide a translation in italics.

1. Metrics is not a subsitute for assessment. Everyone remains responsible for their assessments - *Don't blame it on the metrics*

2. Spend time and money to produce high quality data - *Print your results on glossy paper*

3. Metrics should be transparent and accessible - *Everyone can have a say, even if they don't know shit*

4. Data should be verified by those evaluated - *Be careful not to insult anyone*

5. Be sensitive to field differences - *Use long words to avoid homonyms*

6. Normalize data to account for variations by field and over time - *If your data are useless for one field, make slight adaptations and use them for another field, or try again in ten years*

7. Metrics should align with strategic goals - *Follow the money*

The Daily Issue: Edition 73: http://sti2014.cwts.nl/News?article=n-w2&title=Daily+Issues+now+online!

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(Full text of all articles is available here: http://sti2014.cwts.nl/download/f-y2w2.pdf)

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Section 5:
Expert Opinion

Standardizing research metrics and indicators – Perspectives & approaches

Dr. Gali Halevi & Dr. Lisa Colledge, Elsevier

The increase of data availability and computational advances has led to a plethora of metrics and indicators being developed for different levels of research evaluation. Whether at the individual, program, department or institution level, there are numerous methodologies and indicators offered to capture the impact of research output. These advances have also highlighted the fact that metrics must be applied appropriately depending on the goal and subject of the evaluation and should be used alongside qualitative inputs, such as peer review.

However, this has not solved the challenge of finding core quality and validity measures that will guide the current and future development of evaluative metrics and indicators. While innovation in the field of research metrics is ongoing, funders, institutions and departments are already using output metrics to measure specific elements. Such metrics as are being used cannot be scaled up to global indicators, however. This means that the field now faces a divide: although new metrics exist, they are oftentimes not suitable or cannot be scaled up to the global research ecosystem. Therefore, evaluators still use metrics that have already been recognized as unsuitable measures of individuals' performance, such as journal-level indicators. But for lack of agreed upon alternatives, such metrics are being used routinely in inappropriate circumstances despite their shortcomings.

The need for quality and validity measures that will guide the development of research metrics and ensure that they are applied in an appropriate and fair way is at the heart of several discussions carried out via conferences and listservs, especially in the Scientometrics, Science Policy, and Research Funding communities.

One such panel discussion was held at the Science and Technology Indicators (STI) 2014 conference in Leiden. The panel focused on the need for standardization in the field of research metrics that will speak to their validity, quality and appropriate use and ways to arrive at a consensus. The panel consisted of Dr. Lisa Colledge (Elsevier, Director of Research Metrics), Stephen Curry (professor of Structural Biology at Imperial College, London, and member of HEFCE Higher Education Funding Council for England steering group on the use of research metrics in performance measurement), Stefanie Haustein (University of Montreal), Jonathan Adams (Chief Scientist at Digital Science), and Diana Hicks (Georgia Institute of Technology).

The Snowball Metrics initiative (1), presented by Dr. Lisa Colledge, is an example of research universities collaborating internationally to arrive at a commonly agreed upon set of measures of research (outputs as well as other aspects of the research process). Snowball Metrics' aim is for universities to agree on a set of metrics methodologies that give strategic insight into all of a university's activities. These metrics should be understood by everyone in the same way, so that when universities calculate metrics using these "recipes" they all follow the same protocol (2).

Lisa emphasized that Snowball Metrics welcomes feedback from the research community, to improve the existing recipes and to expand the set of recipes available. Elsevier is involved in Snowball Metrics at the invitation of the universities who drive it, to project manage and to provide technical expertise where needed. The Snowball Metrics program has responded to the HEFCE review (3), and this initiative has significantly influenced Elsevier's overall approach to the use of research metrics, expressed in a response to the same HEFCE review (4). The main principles of Elsevier's manifesto are:

1. A set of multiple metrics distributed across the entire research workflow is needed.
2. Metrics must be available to be selected for all relevant peers.
3. The generation and use of metrics should be automated and scalable.
4. Quantitative information provided by metrics must be complemented by qualitative evidence to ensure the most complete and accurate input to answer a question.
5. The combination of multiple metrics gives the most reliable quantitative input.
6. Disciplinary and other characteristics that affect metrics, but that do not indicate different levels of performance, must be taken into account.
7. Metrics should be carefully selected to ensure that they are appropriate to the question being asked.
8. We cannot prevent the inappropriate or irresponsible use of metrics, but we can encourage responsible use by being transparent, and intolerant of "gaming".
9. Those in the research community who apply metrics in their day-to-day work, and who are themselves evaluated through their use, should ideally define the set of metrics to be used. It is highly desirable that this same community, or those empowered by the community on their behalf, maintains the metric definitions.
10. There should be no methodological black boxes.
11. Metric methodologies should be independent of the data sources and tools needed to generate them, and also independent of the business and access models through which the underlying data are made available.
12. Aggregated or composite metrics should be avoided.

Dr. Ian Viney, Director of Strategic Evaluation and Impact, Medical Research Council, supports this approach, saying that "standards, at least properly described metrics, are important if you want to have reproducibility for your analyses, across different organizations and/or timescales. Evaluation of research, is itself research and development – success and failure should be properly documented." Therefore, "'recipes' should be available for discussion; testing and modification and effective approaches should become accepted standards – methods that everyone can apply." Dr. Viney also commented on the gap between research metrics and the research community saying that:

"The link between these outputs and research activity or impact is little understood. What is most interesting is the development of metrics relating to other logically important areas of research activity – e.g. the ways in which researchers influence policy setting processes, or research feeds into policies, the way in which research teams develop new processes and products, the way in which research materials are disseminated and used. We can make a good argument that these activities are intermediate indicators of impact, they logically describe steps along a pathway to impact. They describe activities however not well reported in any standard format, and data is not readily available on these outputs."

Dr. Ian Viney:
"We should be open about our methods, discussion across stakeholders is helpful, and work such as Snowball Metrics will help accelerate the field. I will be convinced that a particular method should become a standard when it has been successfully and reproducibly applied, when it helps us better understand research progress, productivity and/or quality.

The scientometrics community should provide expert advice to stakeholders regarding the development of suitable approaches. This community has a central role in proposing the most promising methods for wider use."

Dr. Jonathan Adams, Chief Scientist at Digital Science, who participated in the panel, cautioned against rigid setting of standards. In his view "It is infeasible to set comprehensive written standards for metrics, indicators or evaluation methodologies when there is a diverse range of contexts, cultures and jurisdictions in which they might be applied and when data access and data diversity are changing very rapidly." Therefore, his opinion is that any attempt to create such standards would create "an artificial vision of security and stability" that might be used inappropriately by research agencies and managers.

Dr. Paul Wouters, Director of The Centre for Science and Technology Studies (CWTS) and professor of Scientometrics, added his concern regarding standardization of metrics stating that "standards may be important for the construction of databases of research products. So at the technical level they can be useful. However, standards can mislead users if they are essentially captured by narrow interests."

Following the conference, CWTS, a part of Leiden University, published the "The Leiden Manifesto in the Making: proposal of a set of principles on the use of assessment metrics" (5).

In the manifesto Paul Wouters, Sarah de Rijcke and their colleagues summarized some principles around which the debate about standardization and quality should revolve:

1. There should be a connection between assessment procedures and the primary process of knowledge creation. If such a connection doesn't exist then the assessment loses a part of its usefulness for researchers and scholars.
2. Standards developed by universities and data provided should be monitored and benefit from the technical expertise of the Scientometrics community. Although the Scientometrics community does not want to set standard themselves, it should take an active part in documenting them and ensuring their validity and quality.
3. There's a need to strengthen the working relationship with the public nature of the infrastructure of meta-data, including current research information systems, publication databases and citation indexes including those available from for-profit companies.
4. Taking these issues together provides an inspiring collective research agenda for the Scientometrics community.

Dr. Wouters added that the main motivation should be to "prevent misuse or harmful applications by deans, universities or other stakeholders in scientometrics. Although many studies in scientometrics suffer from deficient methods, this problem cannot be solved with standards, but only with better education and software (which may build on some technical standards)."

Dr. Paul Wouters:
"I do not think that global standards are currently possible or even desirable, therefore, Principles of good evaluation practices: YES. Universal technical standards: NO.

The Scientometrics community should analyze, train, educate, clarify, and also take on board the study of how the Scientometric indicators influence the conduct of science and scholarship."

Dr. Peter Dahler-Larsen, a professor at the Department of Political Science at the University of Copenhagen, recently contributed to The Citation Culture blog on the topic of development of quality standards for Science & Technology indicators. Dr. Dahler-Larsen commented on his contribution to Research Trends, saying that "it is important to follow the discussion of standards, because in some fields standards pave the way for a particular set of practices that embody particular values - for better or for worse." The main motivation for the development of standards, added Dr. Dahler-Larsen, is "NOT their agreed-upon character" but rather their ability to "inspire ethical and methodological awareness, and this can take place even without much consensus." Yet, Dr. Dahler-Larsen says that in spite of their importance he "does not have high hopes about the adoption of standards in policy-making."

Dr. Dahler-Larsen:
"The most important function of standards is to raise awareness and debate. Standards can be helpful in discussion of problematic policy-making initiatives.

The Scientometric community has an important role to play because presumably, they comprise experts who knows about the pros and cons and pitfalls related to particular measurement approaches etc. Their accumulated experience should inform better practice."

Dr. John T. Green, who chairs the Snowball Metrics Steering Committee, believes that "whilst some argue that it is impossible to define or agree standard metrics because of the diverse range of contexts and geographies, like it or not, funders and governments are using such measures - some almost slavishly and exclusively (as in Taiwan to allocate government funding). Therefore, whilst it is ideologically acceptable for the Scientometric community to take the high ground and claim that because metrics cannot be perfect therefore none should be developed, to do so is ignoring reality – let us at least do our best and develop metrics as best we can (as indeed has happened over time with bibliometrics). I believe it is important for the academic community to engage and ensure that whatever is used to measure them is fit for purpose, or as fit as can be, especially given that they should never be used in isolation – metrics are only a part, albeit an important part, of the evaluation landscape. Thus the approach of Snowball – bottom-up and owned by the academic community."

Professor Jun Ikeda, Chief Advisor to the President of the University of Tsukuba, Japan, supports the development of standards in metrics. In his view they will save researchers time when reporting to funders. Prof. Ikeda pointed to the fact that in many cases there is a real difficulty to compare universities' performance and says that "If every university defines things in their own way, and calculates metrics in their own way, then seeing a metric that is higher or lower than someone else's is meaningless because the difference might not be real, but just due to different ways of working with the data. I want to do apples to apples comparisons, to be sure that I can be confident in differences that I see, and confident in taking decisions based on them."

Research-focused universities need to be active in defining the metrics that they want to use to give insights into their strategies, Prof. Ikeda said. "Ideally the researchers within our universities would also support and use the same metrics to help them to promote their careers and to understand how they are performing relative to their own peers." Although the debate about whether standardization in research metrics is necessary or even desirable, there is no doubt that the discussion of itself is of importance as it serves as an instrument to raise awareness about the complexity of the topic as a whole. Standards may not be easy to develop or implement, but there is little doubt that consensus regarding their proper use is needed. As more data becomes available and more metrics are developed, the issue of their usefulness and accuracy in different settings becomes crucial. Data providers, evaluators, funders and the Scientometric community must work together to not only aggregate, calculate and produce metrics, but also test them in different contexts and educate the wider audience as to their proper use.

Prof. Ikeda:
"The biggest gap is for the research community to drive the direction that this whole area is going in. A lot is happening, but we feel a bit like it is all being done to us. There is space for us to take control of our own destiny, and shape things as we would like them to be, and as they make the most sense to us."

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Section 6:

Did you know... about the many scientific uses of origami?

Dr. Daphne van Weijen

The traditional Japanese art of paper folding, origami, enables those who use it to produce objects or models from sheets of paper without the use of scissors or glue (1). The most famous example of origami is the Japanese Crane. But did you know that the origami folding technique is also used in scientific research?

A quick search of Scopus.com revealed that there are 1,351 documents indexed in Scopus that contain the term origami in their titles, abstracts or keywords. These are almost all articles, reviews and conference papers, from a wide range of disciplines, including Engineering, Computer Science, Biochemistry, Genetics, Molecular Biology, Chemistry, Materials Science, Physics, Chemical Engineering, Mathematics and Medicine.

The most interesting examples of the variety of uses of origami in science include the use of the Origami Cleft Lip technique in Plastic Surgery (2), and RNA and DNA folding techniques based on origami in Biology and Genetics research (3, 4).

References:

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