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Research Trends on Open Science: A Bibliometric Analysis and Visualization

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Abstract

This study examines Open Science research output at a global level from 1989 to 2021.The data was obtained from the Web of Science database. During the study, 1301 records were retrieved. The data was then visualized using VOSviewer software version 1.1.16. The finding revealed that Ross, Joseph S., and Bradley, Jean-Claude were the most prolific authors, with 7 documents. The leading organization on open science research was the MCGILL University, with 25 documents. Furthermore, the United States had supplied 442 documents, followed by England with 169 and Germany with 113. The finding indicates that there was a steady increase in open science research during the study period.

Keywords: *Bibliometric analysis; Visualization; Open Science; Open innovation; Research Trends; Web of Science; VOSviewer*

Introduction

People are concerned about the future of science at this time. The fact that scientific policy circles have become enamored of open science is all the more remarkable. The whole thing started in the late 2000s with murmurs about something called 'Science 2.0'. In January 2012, The New York Times had the foresight to promote the rebranding of this notion as "open science" (Mirowski, 2018). By bringing about socio-cultural and technological change based on openness and connectedness, Open Science has an impact on how research is conducted, executed, gathered, and appraised (Vicente-Saez& Martinez-Fuentes, 2018). As a result, Open Science is a new field of study.

Furthermore, in the field of library and information science, bibliometrics is a significant area of study. Pritchard coined the term bibliometrics in 1969 to describe a statistical strategy for quantifying all fields of knowledge (Patel et al., 2021). Several bibliometric analytical tools, such as VOSviewer, have also been developed to help scholars to better comprehend and analyzed the development and evolution trend. The goal of this study is to look at bibliometrics and visualizations of open science research.

Related Works

Many researchers have undertaken bibliometric analyses in numerous domains in recent years. The following are some instances of such research studies:

Murnaka et al. (2021) conducted a bibliometric study and visualization on educational technology research. This study analyzed that most cited writers were Liu, H., Ellaway, R., and Skiba, D.J. Aristovnik, Ravšelj, and Umek (2020) performed a bibliometric analysis of COVID-19 across science and social science research. The finding of the study reaveals that the USA, China and Italy dominate in COVID-19 research. Zurita et al. (2020) presented a bibliometric study in computer science research and observed that Massachusetts Institute of Technology (MIT), University of California Berkeley, Stanford University and International Business Machines (IBM) had the highest number of citations. Wang, Ho, and Fu (2019) studied a bibliometric analysis on sustainable city research based on natural science and social science. The study's findings concluded that China rated top in natural scientific research, while the United States ranked first in social science research. Laengle et al. (2018) explored the bibliometrics in operations research and management science. This study revealed that the Centre National de la Recherche Scientifique (CNRS) of France was the most productive university in a particular field.

Objectives of the Study

The following objectives of the study are:

1. To examine the publication trends with the citation on open science research during 1989-2021;
2. To study the visualization of the most productive and influential authors, most productive organizations, and countries; and
3. To find out keyword co-occurrence network visualization.

Methodology

The aim of the research is to provide a bibliometric analysis and visualization of open science research from 1989 to 2021. The data for this study was taken

from the Web of Science database. Web of Science is a bibliographic database that provides comprehensive citation data for various academic disciplines. The search keyword used "Open Science"in the title field. A total of 1301 records were retrieved on October 12, 2021, from global research publications on open science. After extracting the data, it was subsequently tabulated, examined, and analyzed. Also, the VOSviewer software version 1.6.16 was used to visualize the researched data as a network.

Results and Discussion

Year-wise Growth Trends of Documents and Citations

A total of 1301 Open Science documents indexed in Web of Science were reviewed in this study. Figure 1 shows the progress trend of published documents on Open Science from 1989-2021. Most documents (n=147) published in 2021. The publication trend of Open Science has increased from 1989 to 2021. Also, the citation trend of the documents published on Open science is shown in figure 1. A review of citations indicated that the documents of Open Science received 16434 citations from 1989-2021. The data distribution in figure 1 indicated that the trend of citations received by the document was ascending.

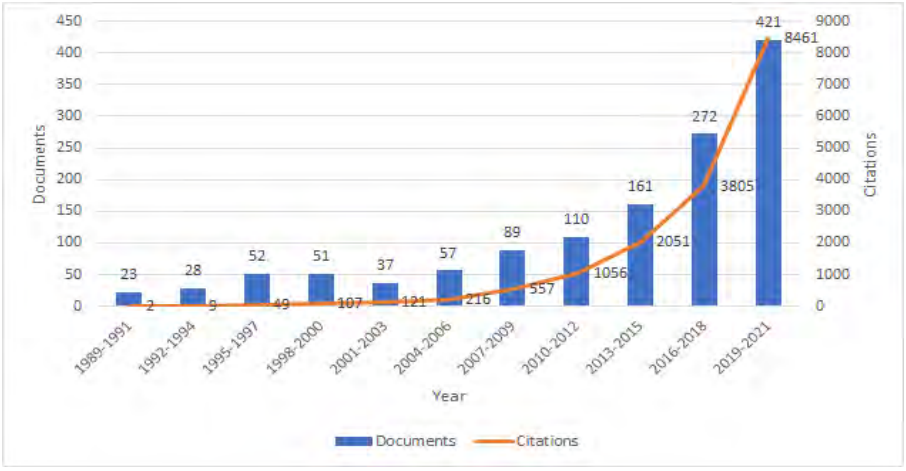

Figure 1: Year-wise growth trends of documents and citations

Visualization of the Most Productive and Influential Authors

Figure 2 indicates the densityvisualization of the most productive and influential authors. For mapping VOSviewer software used, the threshold was considered 10, and 33 authors with at least 3 documents in Open Science research could enter the density map. The yellow circle on this map represents

the number of documents. In other words, the larger the number of documents an author has the more yellow circles. As shown in the density map, the authors, including Ross, Joseph S. (7 documents), Bradley, Jean-Claude (7 documents), Krumholz, Harlan M. (6 documents), Therrien, William J. (5 documents), and Hesse, Bradford W. (5 documents) were considered as the most productive and influential authors.

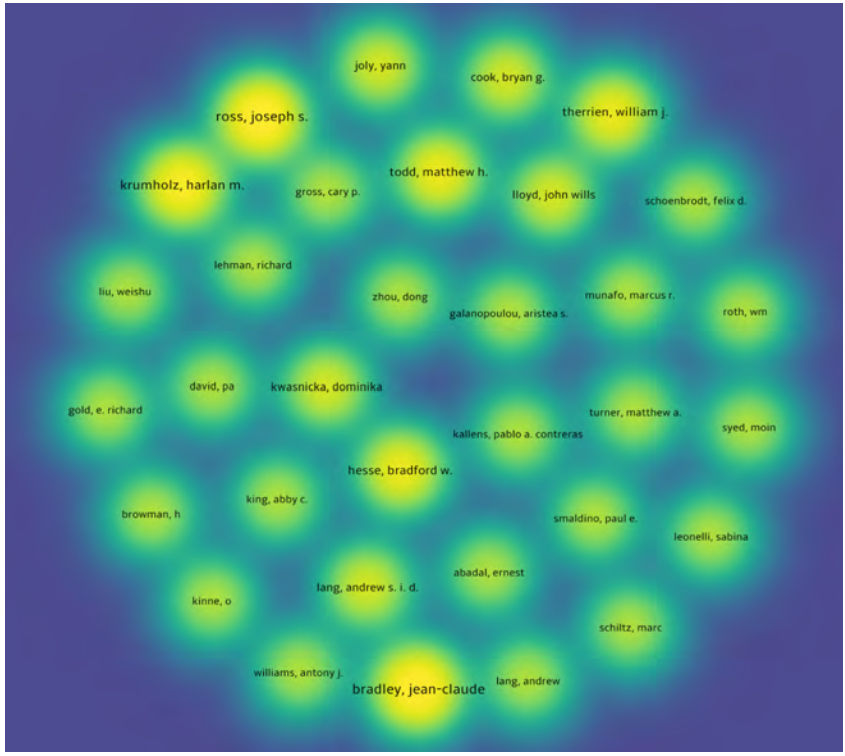

Figure 2: Visualization of the most productive and influential authors

Visualization of the Most Productive Organizations

Figure 3 shows the visualization of the most productive organizations on Open science research. The minimum number of documents of an organization was 5 fixed. Out of 1396 organizations, 83 meet the thresholds. In the figure, the bigger circle size indicates that the organizations are more productive. Therefore, the five organizations were most productive on Open Science research as follows: MCGILL University (25 documents), University of Oxford (18 documents), University College London (18 documents), University of Toronto (18 documents), and Stanford University (18 documents).

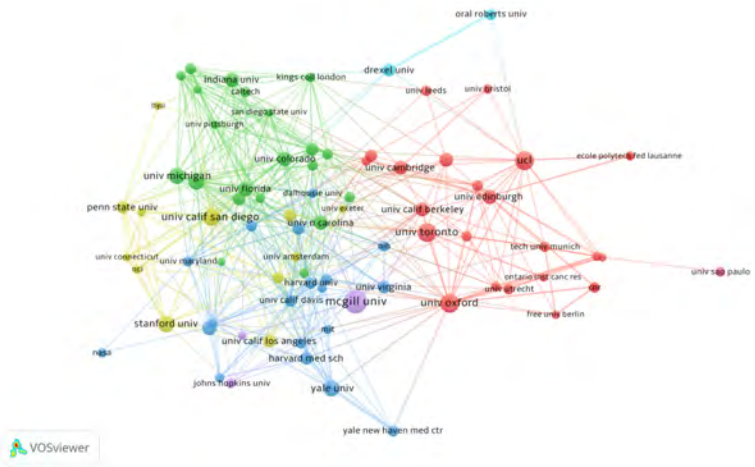

Figure 3: Visualization of the most productive Organizations

Visualization of the Most Productive Countries

Visualization of the most productive countries is shown in Figure 4. The data of visualization indicated that authors of 79 countries published documents on Open science. The minimum number of documents of an individual country was 5 fixed. Therefore, 36 countries meet the thresholds. The bigger the frame size indicates that the country publishes a more significant number of documents. The figure shows that "USA" as the most productive country with 442 documents was the first rank. With 169 and 113 documents, respectively, "England" and "Germany" were ranked second and third.

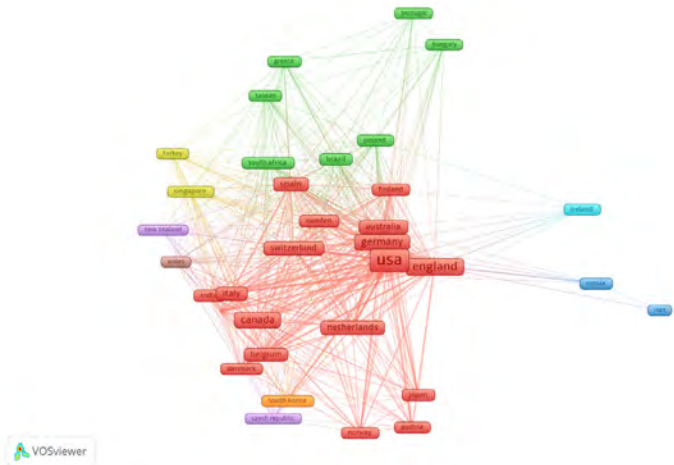

Figure 4: Visualization of the most productive Countries

Keyword Co-occurrence Network Visualization

Keywords serve as a summary of the literature and a description of the study's emphasis. The keywords present the core topic of the research article. The authors utilized the VOSviewer software to visualize the keyword co-occurrence network. In figure 5, all the keywords are divided into the following five clusters, indicated in red, green, blue, yellow, and purple, to represent the subdomains of the concept 'Open Science'. The red color can characterize the first cluster that deals with ideas like "Knowledge","Technology", and "Innovation". The second cluster in green color consists of keywords, including "Open Access","Journals", and "Publication". Cluster 3 is represented by a blue color that deals with "Open Science","Reproducibility", and "Replication". The fourth cluster in yellow color includes keywords such as "Citizen Science","Challenges", and "Open Sources". Purple color represents the fifth cluster that deals with ideas like "Education","Students", and "Thinking".

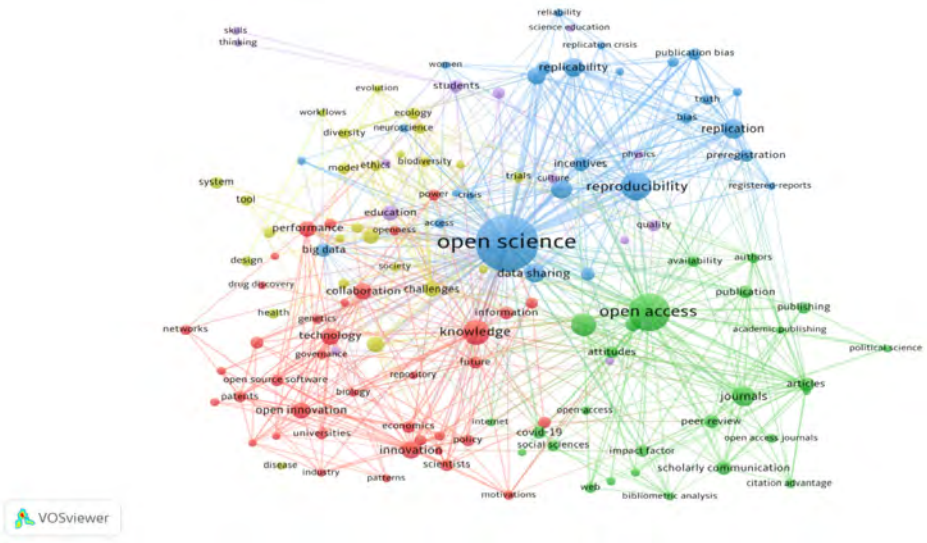

Figure 5: Keyword co-occurrence network visualization

Conclusion

This study aimed to perform a bibliometric analysis and visualization of research on Open Science from 1989-2021. It indicates an increase in trends in the documents year by year. It is also observed that Ross, Joseph S., and Bradley, Jean-Claude were the most productive and influential authors. It was noticed that the MCGILL University is a most productive organization on open

science research. Further, it is observed that most of the open science research is produced by the USA. These findings highlight the use of bibliometric tools in determining worldwide research trends in open science. Open Science is a disruptive phenomenon that is emerging around the world. However, this study will give good comprehension for the new researchers who want to research open science.

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