

## Mapping Research Developments on Mathematics Communication: Bibliometric Study by VosViewer

Ismail Hanif Batubara<sup>1</sup>, Sahat Saragih<sup>2</sup>, Edi Syahputra<sup>3</sup>, Dian Armanto<sup>4</sup>, Indah Purnama Sari<sup>5</sup>, Baihaqi Siddik Lubis<sup>6</sup>, Eko Febri Syahputra Siregar<sup>7</sup>

<sup>1</sup> Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia; ismailhanif@umsu.ac.id

<sup>2</sup> Universitas Negeri Medan, Indonesia; saragihpps@gmail.com

<sup>3</sup> Universitas Negeri Medan, Indonesia; edisyahputra01.es@gmail.com

<sup>4</sup> Universitas Haji Sumatera Utara, Medan, Indonesia; dianarmanto@unhaj.ac.id

<sup>5</sup> Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia; indahpurnama@umsu.ac.id

<sup>6</sup> Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia; baihaqisiddik@umsu.ac.id

<sup>7</sup> Universitas Maritim Raja Ali Haji, Kepulauan Riau, Indonesia; ekofebriyahputrasiregar@umrah.ac.id

---

### ARTICLE INFO

#### *Keywords:*

Mapping Research;  
Mathematics Communication;  
Bibliometric;  
Vosviewer;  
Science Direct

---

#### *Article history:*

Received 2022-02-05

Revised 2022-04-03

Accepted 2022-07-02

---

### ABSTRACT

This research aims to determine the map of the development of research on Mathematics Communication, namely a study of bibliometrics by VosViewer. The study was conducted starting in January 2021 by searching the keyword "Mathematics Communication" in the Science Direct database and choosing the open access system. The search result data is then stored in the form of a Research Information System (RIS) and analyzed descriptively using VosViewer to see developments on the topic from year to year, the types of documents that are widely published, the name of the author who has discussed the most about the case, the name of the publishing institution and the topics that appear most frequently from thousands of journals that have been processed using VosViewer. The results showed that the map of the development of research on Mathematics Communication has existed since 1997 and increases rapidly from year to year. The article that publishes the most on this topic is Research Articles with the publisher's name Procedia Computer Science as many as 2662 documents. Meanwhile, the author who published the most on this topic was Yusof, Yudariah Mohammad, until May 28, 2021. The most dominant issue that appears was "communication", followed by the topic of "systems" and "students". Network visualization shows that a line demonstrates the relationship between issues between the descriptors in each field. The more relationships between the lines indicate the closer relationships between documents.ch on that topic.: Indicate the main conclusions or interpretations.

*This is an open access article under the [CC BY-NC-SA](https://creativecommons.org/licenses/by-nc-sa/4.0/) license.*



---

#### **Corresponding Author:**

Ismail Hanif Batubara

Universitas Muhammadiyah Sumatera Utara, Medan, Indonesia; ismailhanif@umsu.ac.id

---

## 1. INTRODUCTION

Communication is one of the most important abilities in everyday life because communication is a way of sharing and can clarify an understanding (Batubara, Saragih, Simamora, Napitupulu, & Sari, 2022). Through communication, mathematical ideas can be conveyed in the form of symbols, notations, graphs, and terms (Maisyarah & Surya, 2017), (Mushlihuiddin & Wahyuni, 2017). Mathematical communication is also a tool that can be used to solve mathematical problems. According to the Dictionary of Indonesian, communication is the sending and receiving of messages between two or more people so that the message in question can be understood (Batubara, Nur, Lubis, & Arianto, 2021). But there are some experts who put forward their opinion on communication, among others: a. Mathematical communication skills are the ability to convey mathematical ideas as well as the ability to understand and accept other people's mathematical ideas carefully, analytically, critically, and evaluatively to sharpen understanding (Syukri, Marzal, & Muhaimin, 2020). b. Communication is the process of conveying information, ideas, emotions, expertise, and others through symbols such as words, images, numbers, and others (Rahmy, Usodo, & Slamet, 2019). c. Communication is the act of carrying out contact between the sender and the recipient, with the help of messages; the sender and receiver have some experience together that gives meaning to messages and symbols sent by the sender, and received and interpreted by the recipient (Nuraida & Amam, 2019), (Dachi & Batubara, 2020).

Bibliometrics analysis or methods (bibliometrics) are sometimes also referred to as scientometrics which is part of the research evaluation methodology, and from various literature which has been widely generated, allowing the implementation of bibliometric analysis with using a separate method (Ellegaard & Wallin, 2015), (Dolhey, 2019). One of the uses of this bibliometric analysis is to map a research topic with certain keywords, abstracts, or titles that have been carried out by various researchers from all over the world (Md Khudzari, Kurian, Tartakovsky, & Raghavan, 2018), (Tibaná-Herrera, Fernández-Bajón, & De Moya-Anegón, 2018).

Research using bibliometric methods can also reveal the fact that there are still many uncited studies, recent research trends, and so on (Khalil & Gotway Crawford, 2015), (Donthu, Kumar, & Pattnaik, 2020). Bibliometric mapping would benefit either the scientific community as well as the public in general because it can help turn publication metadata into maps or visualizations through VosViewer, which is easier to manage to process in order to gain useful insights, for example visualizing keywords to identify research themes or clusters in certain disciplines, mapping author affiliations from specific journals to identify geographic coverage of journals, and map collaborations institutional and international collaboration as part of a framework for identifying emerging technologies (Tanudjaja & Kow, 2018), (Galvao, Mascarenhas, Marques, Ferreira, & Ratten, 2019).

Basically, bibliometric studies have a positive impact on various matters related to scientific literature, including the identification of literature, the direction of research symptoms and the growth of knowledge in various different disciplines, suspecting the breadth (comprehensiveness) of secondary literature, recognizing the authorship and direction of symptoms in documents various subjects, compiling pad arak documents appropriately and regularly, examining obsolescence and dissemination of scientific literature, knowing research gaps and enriching the amount of research for the field of information science, and being able to develop library collections in a more directed manner (Irianti, 2016). All bibliometric studies are carried out to determine the mapping of research (Batubara, Sari, et al., 2022)

Mapping is a process that allows a person to recognize an element's knowledge as well as its configuration, dynamics, mutual dependence, and interaction. Knowledge mapping used for technology management purposes, includes program definitions research, decisions concerning activities related to technology, the design of base structures knowledge, as well as the creation of educational and training programs. In relation to bibliometrics, the mapping of science is a method of visualization of a field of science. This visualization can be done with the help of VosViewer software and is done by creating a map of the relationship between one topic and another, one keyword with

another keyword, and so on (Sweileh, Al-Jabi, Zyoud, & Sawalha, 2018). On the map will appear topics from science. The inputs are bibliographic data, keywords, citations, etc.

Bibliometric mapping using the VosViewer application will benefit both the scientific community as well as the public in general because it can help change the metadata of publications into maps or visualizations, which are easier to manage to process in order to gain insights which is useful, for example visualizing keywords to identify research themes or clusters in a particular discipline, mapping author affiliations from specific journals to identify the geographic scope of journals, and mapping institutional collaborations and collaborations international as part of a framework for identifying emerging technologies (Tanudjaja & Kow, 2018). However, to map hundreds of journals from various countries, look for the relationship of one keyword with another keyword in the title and abstract of hundreds or even thousands of journals are a silly or futile way if done manually. This reason makes researchers interested in seeing maps or the relationship between Mathematics Communication and Keywords in other titles / abstracts from thousands of articles around the world that have published about "Mathematics Communication" based on data taken from Science Direct. Research on Mathematics Communication has been done a lot by experts both in the field of mathematics and in other sciences. Mathematics Communication that will be studied in this study is to map what has been studied related to Mathematics Communication both from education, lecturers, students, and from non-education.

## 2. METHODS

This research is a bibliometric literature study of the research development map on the topic of Mathematics Communication which is carried out with the help of the VosViewer application. Broadly speaking, this study was carried out by searching through the Science Direct database (<https://www.sciencedirect.com/>) uses the term or keyword Open access and Mathematics Communication Through the search field "Document Search". Then the document that appears will be downloaded and stored in a form of Research Information Systems (RIS) file. A RIS file is a bibliographic citation file saved in a format developed by Research Information Systems. This file contains a series of lines delimited by a two-character code and the corresponding values. RIS files provide information such as title, author, publication date, keywords, publisher, issue number, and start and end pages. For this Study, the RIS files are retrieved and what will be analysed is a RIS file related to "Mathematics Communication" either in the research title, Abstract or Keywords.

Furthermore, the RIS data will be analysed using the help of Vos Viewer. VosViewer will analyze the data and categorize the RIS data taken from thousands of such journals to be categorized into several research clusters on Mathematics Communication. The result will be presented in the form of visualization of hundreds of articles based on clusters, relationships, or relationships of communication mathematics keywords with others that appear in the research that has been carried out. Term or research topic that is rarely studied that is still related to the topic of "Mathematics Communication" either directly or indirectly direct (Fahimnia, Sarkis, & Davarzani, 2015).

## 3. FINDINGS AND DISCUSSION

### Published Year Development of Research "Mathematics Communication"

The results of a search through a Science Direct search show that the development of research on "Mathematics Communication" towards Open access has existed since 1997. In that year as many as 448 documents could be accessed via the internet more easily than from year to year, it increased rapidly to the position of 956 documents in 2010 and as many as 1468 documents in 2021 as of May 28, 2021. For more details on the map of the development of Mathematics Communication research from year to year can be seen in the table below:

**Table 1.** Development of Mathematics Research Communication By Year

Year	Number of Document	Year	Number of Document
2021	1468	2008	789
2020	2200	2007	782
2019	1807	2006	812
2018	1712	2005	612
2017	1484	2004	300
2016	1681	2003	308
2015	2273	2002	185
2014	1673	2001	182
2013	1497	2000	210
2012	1686	1999	332
2011	1298	1998	446
2010	956	1997	448
2009	825		

From the table, it can be seen that the map of research developments every year continues to increase. This indicates that the topic of Mathematics Communication is very important to study and has many benefits and relationships with other disciplines.

Types of Articles That Contain "Mathematics Communication" on the Research Development Map  
As for the Type of Article that has been published about "Mathematics Communication both a title, abstract, keyword, and content can be seen in the table below:

**Table 2.** Types of Articles that Contain "Mathematics Communication"

Type of Articles	Number of Document	Type of Articles	Number of Document
Review Articles	1500	Editorials	249
Research Articles	27073	Errata	37
Book Chapters	2	Mini-Reviews	177
Conference Abstracts	358	News	35
Book Reviews	378	Practice Guidelines	10
Case Reports	6	Product Reviews	1
Conference Info	46	Short Communication	904
Correspondence	67	Software Publications	26
Data-Articles	34	Others	1336
Discussion	85		

From the table above, it can be seen that the highest number of documents discussing Mathematics Communication is Research Articles with 27073 documents followed by Review Articles with 1500 documents.

The Name of the Journal That has been Published about "Mathematics Communication"

The names of publications that have been published about "Mathematics Communication both as a title, abstract, keywords, and content can be seen in the table below:

**Table 3.** Name of the Journal that Contains "Mathematics Communication"

Name of Journal	Sum	Name of Journal	Sum
Procedia Computer Science	2662	Journal of Computational and Applied Mathematics	560
Procedia Social and Behavioral Sciences	2113	Linear Algebra and its Applications	529
Theoretical Computer Science	1303	Journal of Mathematical Analysis and Applications	451
Discrete Mathematics	1227	Journal of Biological Chemistry	398
Computer & Mathematics with Applications	1189	Journal of Computer and System Science	335
Discrete Applied Mathematics	1147	Science of Computer Programming	327
Procedia CIRP	1039	Energy Procedia	296
Mathematics and Computer Modelling	755	Transportation Research Procedia	291
Procedia Engineering	686	Information and Control	281
Electronic Notes in Theoretical Computer Science	670	Applied Mathematics Letter	277
Biophysical Journal	618	Journal of Dairy Science	273
Procedia Manufacturing	598	Stochastic Processes and Their Applications	266
Applied Mathematics Modelling	576		

From the table above, we can conclude that the name of the publisher that publishes the most Mathematics Communication is Procedia Computer Science with 2662 documents followed by Procedia Social and Behavioral Sciences with 2113 documents. All of the data was obtained using a "Science Direct" search with the keyword "Mathematics Communications" with Open access.

#### Map of Mathematics Communication Co-Author

After conducting a subject analysis to determine the field of each Mathematics Communication research map through science direct tracing with Open access, it was found that several authors wrote a lot about Mathematics Communication from thousands of journals with criteria of at least 5 journal documents that had been written and published. As a result, there are only 13 authors who write articles on Mathematics Communication with the criteria for articles written by at least 5. The names of these authors along with the number of documents that have been written about Mathematics Communication (Minimum 5) with a total link are shown in the figure below:

Selected	Author	Documents	Total link strength
<input checked="" type="checkbox"/>	suradi, nur riza mohd	7	32
<input checked="" type="checkbox"/>	rambely, azmin sham	7	31
<input checked="" type="checkbox"/>	majid, noriza	6	30
<input checked="" type="checkbox"/>	din, ummul khair salma	5	26
<input checked="" type="checkbox"/>	muda, nora	5	25
<input checked="" type="checkbox"/>	ali, zalina mohd	5	24
<input checked="" type="checkbox"/>	shahabuddin, faridatulazna ahmad	6	24
<input checked="" type="checkbox"/>	yusof, yudariah mohammad	10	19
<input checked="" type="checkbox"/>	ismail, zaleha	7	16
<input checked="" type="checkbox"/>	kashefi, hamidreza	7	16
<input checked="" type="checkbox"/>	rahman, roselainy abdul	5	11
<input checked="" type="checkbox"/>	tarmizi, rohani ahmad	6	0
<input checked="" type="checkbox"/>	world dental federation, fdi	6	0

Figure 1. Author Name and Total Link on Mapping Mathematics Communication

From the picture above, it can be seen that the author on behalf of Yusof, Yudariah Mohammad is the author of the most authors about Mathematics Communication which is traced from Data Science Direct with Open access. While the author who has the most network is Suradi, Nur Riza Mohd.

### Visualization Network Author Mathematics Communication

From the results of searching the Science Direct database with the Type Open access, researchers downloaded 1000 documents then exported them into RIS format, inputted, and analyzed them using VosViewer. From the results of the analysis obtained in the results of network visualization as many as 13 authors. The network Visualization of the co-author is shown in the figure below:

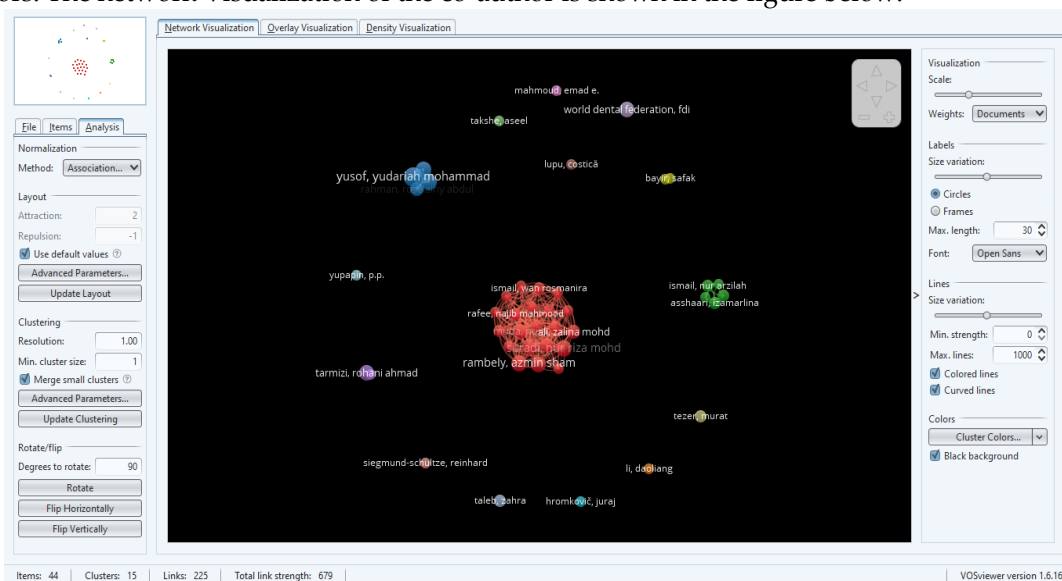


Figure 2. Visualization Network Author Mathematics Communication

From the image above, it can be seen that there are several authors who have links with one another. But there are also those who have no links at all. The most numerous links are indicated by the image of the largest coil called cluster 1. If cluster 1 is enlarged it will look like the image below:



group	233	0,57
paper	417	0,54
study	559	0,45
application	182	0,41
order	143	0,39
level	190	0,26
effect	200	0,15

From the table above, it can be seen that there are 25 topics that most often arise from thousands of topics. These topics appear at least 29 times. If a topic only appears under 29 times, then it is automatically eliminated. The topic that most often appears is "Communication" 746 times followed by "system" 633 times and "student" 598 times.

### Visualization of Network Topics in Mathematics Communication

Based on the results obtained in table 4 above, the results of the visualization of the 79 topics after being processed using VosViewer can be seen in the figure below:



Figure 4. Visualization of Network Topics in Mathematics Communication

Figure 4 above, shows that the mathematics communication research development map is divided into 3 main clusters. The clusters are marked with three color fruits that appear in the image. The explanation of the three clusters is Cluster 1 red color consists of 38 topics including algorithm, application, Communication, Communication complexity, Communication network, Communication system, efficiency, framework, model, group, operation, function, graph, evolution, and network. Cluster 2 green color consists of 30 items including activity, attitude, case study, mathematics education, education, course, Communication skills, researcher, school, learning, mathematics, knowledge, computer, participant, and question. Cluster 3 blue color consists of 11 topics, namely base, Communication technology, control group, difference, effect, group, ICT, level, mathematical model, mathematical modeling, and patient.

### Visualization of Density on the Topic of Mathematics Communication

Density is an item (label) that is marked the same as the visible item. Each item point has a color that depends on the density of the item that appears on the image. It identifies that the color of the dots





the relationship between research topics is shown with lines between descriptors in each field. The more lines of relationship between descriptors, the closer the relationship between the documents will be. Meanwhile, the visualization of density shows that the relationship between topics is getting yellower, the tighter it will be and the greener it will be, the less it will be researched.

**Acknowledgments:** I would like to thank all the authors who have participated in completing this research. Thank you also to the research and community service institute of the Universitas Muhammadiyah Sumatera Utara for providing funds in completing this research. Hopefully, this writing will be useful for the author in particular and for the reader in general.

**Conflicts of Interest:** There is no conflict of interest

## REFERENCES

- Batubara, I. H., Nur, K., Lubis, A. T., & Arianto, N. (2021). The Effectiveness of Learning Using Social Media during the Covid 19 Pandemic in Higher Education. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, 4(2), 2177–2183. <https://doi.org/10.33258/birci.v4i2.1908>
- Batubara, I. H., Saragih, S., Simamora, E., Napitupulu, E. E., & Sari, I. P. (2022). Analysis of Student ' s Mathematical Communication Skills through Problem Based Learning Models Assisted by Augmented Reality. *Budapest International Research and Critics in Linguistics and Education (BirLE) Journal*, 5(1), 1024–1037.
- Batubara, I. H., Sari, I. P., Andini, P., Jannah, M., Saragih, S., Sinaga, B., ... Lubis, B. S. (2022). Bibliometric Mapping on the Research "Merdeka Belajar" Using VosViewer. *Jurnal Pendidikan Progresif*, 12(2), 477–486. <https://doi.org/10.23960/jpp.v12.i2.202207>
- Dachi, S. W., & Batubara, I. H. (2020). The Development of Learning Model Through Problem Based Introduction ( PBI ) on Student ' s Motivation Improvement in Mathematics Education. *International Journal for Educational and Vocational Studies*, 2(2), 174–177.
- Dolhey, S. (2019). A bibliometric analysis of research on entrepreneurial intentions from 2000 to 2018. *Journal of Research in Marketing and Entrepreneurship*, 21(2), 180–199. <https://doi.org/10.1108/JRME-02-2019-0015>
- Donthu, N., Kumar, S., & Pattnaik, D. (2020). Forty-five years of Journal of Business Research: A bibliometric analysis. *Journal of Business Research*, 109(October 2019), 1–14. <https://doi.org/10.1016/j.jbusres.2019.10.039>
- Ellegaard, O., & Wallin, J. A. (2015). The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*, 105(3), 1809–1831. <https://doi.org/10.1007/s11192-015-1645-z>
- Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. In *International Journal of Production Economics* (Vol. 162). Elsevier. <https://doi.org/10.1016/j.ijpe.2015.01.003>
- Galvao, A., Mascarenhas, C., Marques, C., Ferreira, J., & Ratten, V. (2019). Triple helix and its evolution: a systematic literature review. *Journal of Science and Technology Policy Management*, 10(3), 812–833. <https://doi.org/10.1108/JSTPM-10-2018-0103>
- Irianti, P. (2016). Studi Bibliometri Media Komunikasi Ilmiah Berkala Ilmu Perpustakaan dan Informasi. *JURNAL IPTEKKOM: Jurnal Ilmu Pengetahuan & Teknologi Informasi*, 18(1), 69–80. <https://doi.org/10.33164/iptekkom.18.1.2016.69-80>
- Khalil, G. M., & Gotway Crawford, C. A. (2015). A bibliometric analysis of U.S.-based research on the behavioral risk factor surveillance system. *American Journal of Preventive Medicine*, 48(1), 50–57. <https://doi.org/10.1016/j.amepre.2014.08.021>
- Maisyarah, & Surya. (2017). Kemampuan Koneksi Matematis ( Connecting Mathematics Ability ) Siswa dalam Kemampuan Koneksi Matematis ( Connecting Mathematics Ability ) Siswa dalam Menyelesaikan Masalah Matematika. *Jurnal Pendidikan Matematika*, 2(1), 0–8. Retrieved from [https://www.researchgate.net/publication/321803645\\_Kemampuan\\_Koneksi\\_Matematis\\_Connec](https://www.researchgate.net/publication/321803645_Kemampuan_Koneksi_Matematis_Connec)

- ting\_Mathematics\_Ability\_Siswa\_dalam\_Menyelesaikan\_Masalah\_Matematika
- Md Khudzari, J., Kurian, J., Tartakovsky, B., & Raghavan, G. S. V. (2018). Bibliometric analysis of global research trends on microbial fuel cells using Scopus database. *Biochemical Engineering Journal*, 136, 51–60. <https://doi.org/10.1016/j.bej.2018.05.002>
- Mushlihuiddin, R., & Wahyuni, S. (2017). *The Influence of the PBL Model to Improve the Student's Mathematical Ability of Reasoning and Proof*. (October), 13–14.
- Nuraida, I., & Amam, A. (2019). Hypothetical Learning Trajectory in Realistic Mathematics Education To Improve the Mathematical Communication of Junior High School Students. *Infinity Journal*, 8(2), 247. <https://doi.org/10.22460/infinity.v8i2.p247-258>
- Rahmy, S. N., Usodo, B., & Slamet, I. (2019). Mathematics communication skill of student in junior high school based on students thinking style. *Journal of Physics: Conference Series*, 1188(1). <https://doi.org/10.1088/1742-6596/1188/1/012107>
- Sweileh, W. M., Al-Jabi, S. W., Zyoud, S. H., & Sawalha, A. F. (2018). Bibliometric analysis of literature in pharmacy education: 2000–2016. *International Journal of Pharmacy Practice*, 26(6), 541–549. <https://doi.org/10.1111/ijpp.12429>
- Syukri, A., Marzal, J., & Muhaimin, M. (2020). Constructivism-Based Mathematics Learning Multimedia to Improve Students' Mathematical Communication Skills. *Indonesian Journal of Science and Mathematics Education*, 3(2), 117–132. <https://doi.org/10.24042/ijmsme.v3i2.6201>
- Tanudjaja, I., & Kow, G. Y. (2018). Exploring Bibliometric Mapping in NUS using BibExcel and VOSviewer. *IFLA WLIC Kuala Lumpur*, 1–9. Retrieved from <http://library.ifla.org/2190/1/163-tanudjaja-en.pdf>
- Tibaná-Herrera, G., Fernández-Bajón, M. T., & De Moya-Anegón, F. (2018). Categorization of E-learning as an emerging discipline in the world publication system: a bibliometric study in SCOPUS. *International Journal of Educational Technology in Higher Education*, 15(1), 1–23. <https://doi.org/10.1186/s41239-018-0103-4>

