Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

Citizen Science Project: A Bibliometric Analysis (2014–2023)

Fitri Aryanti[1,2], Topik Hidayat[1,*], Yayan Sanjaya[1], Kusnadi Kusnadi[1]

[1] Department of Biology Education, Faculty of Mathematics and Science Education, Universitas Pendidikan Indonesia, Kota Bandung, Jawa Barat 40154, Indonesia
[2] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Pasundan, Kota Bandung, Jawa Barat 40116, Indonesia

ABSTRACT

This research was conducted to determine research trends regarding citizen science projects using bibliometric analysis Data was obtained through the Scopus database using the keyword "citizen science project" and limiting the search for articles in the last ten years from 2014 to 2023. The database obtained was exported in RIS and CSV form, and then the metadata obtained was analysed using the tool VOSviewer software that produces density and overlay visualization. The results show that citizen science project research is divided into 8 clusters. The number of publications from 2014 to 2021 has increased to 86 articles, and in 2022 the number of publications has decreased to 79. The results of this analysis show that research on citizen science projects has excellent opportunities to be linked to other variables and as a reference for further research that will be applied in the field of Biology Education.

Keywords:
Bibliometric analysis; citizen science project; scopus database; VOSviewer

1. Introduction

Recently, citizen science projects have often been a topic of conversation in various fields. With increasing amounts of research regarding citizen science project, this provides evidence in the form of learning outcomes achieved through the public participation process [1]. Citizen science project is a data collection activity that is researched and carried out in collaboration between group members to solve problems so that they can provide solutions. Citizen science involves the public collaborating with professional scientists in scientifically based research to conduct investigations and solve problems together [2,3]. Program citizen science is carried out to collect and analyse scientific value information, including obtaining conservation data for a particular species. Through this program, it can help increase new knowledge, skills and increase community participation [4].

Citizen science has great potential, especially in the field of science education and learning [5]. Citizen science is carried out by involving public participation, such as observing nature, monitoring biodiversity and observing species, so participants need to be equipped with the knowledge and motivation to contribute to conservation activities [6,7]. Several studies have shown that citizen science projects are growing in various countries [8].

* *Corresponding author.*
E-mail address: topikhidayat@upi.edu

https://doi.org/10.37934/araset.55.2.125135

The development of research regarding citizen science projects can be seen based on bibliometric analysis. Bibliometrics is software for mapping scientific trends in various scientific disciplines by identifying and analysing the scientific performance of authors, articles, journals, and countries through keyword analysis which can provide an overview for researchers as directions related to scientific research themes [9,10]. There are several studies regarding bibliometric analysis, including in the fields of health [11], covid-19 [12,13], food [14], economics [15], environment [16] and many more

Therefore, this research was conducted to carry out computational mapping analysis of citizen science project articles using the VOSviewer application, so that this research can be used as a reference for researchers to conduct and determine research topics related to citizen science projects, especially in biology education and related to technology or other variables.

2. Methodology

The method used in this research is the bibliometric method. The data analysed in this research was obtained from the Scopus database. Scopus is the most complete citation or scientific literature database launched in 2004 [17,18]. The initial search stage in May 2023 obtained available documents with the keyword "citizen science project" a total of 1,468 articles, then restrictions on article searches were carried out in the last 10 years, namely 2014-2023. The document type chosen was articles with journal publications in English, and 423 were obtained. The article search results are then exported in RIS format which can be analysed using VOSviewer, and CSV format which can be analysed using Microsoft Excel [19]. The research method used adopted a five-step method [20-22].

Figure 1 shows the stages of searching for citizen science project documents. Details of the bibliometric analysis citizen science project are as follows:

i. Determine keyword searches. This stage conducted a literature search via scopus.com in May 2023 using the keyword 'citizen science project'.
ii. Initial Search Results. In this second stage, 1.468 articles about the citizen science project were obtained.
iii. Improved search results. The 1.468 articles obtained were then filtered into the last ten years (2014-2023) with the document type being a journal, and the final results obtained were 423 articles.
iv. Preparation of initial data statistics. The data collected is stored in RIS and CSV form by checking the completeness of journal components, including title, year of publication, volume, number, pages, etc.
v. Data analysis. Metadata is obtained as RIS and CSV, which are then analysed using VOSviewer [23]. VOSviewer was released in 2010 by Nees Jan van Eck and Ludo Waltman (Leiden University) [24]. VOSviewer is software with a distance-based approach to visualize bibliometric networks [25]. Based on the metadata that has been obtained, it is then analysed using VOSviewer which can be used to analyse and visualize bibliometric relationships regarding research citizen science project.

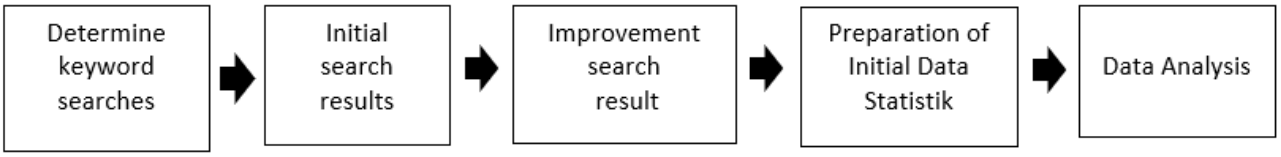

Fig. 1. The stages of searching for citizen science project documents

3. Results

3.1 Publication of Data Search Results

Based on search results on Scopus, 423 articles met the research criteria. The data obtained is displayed as article metadata consisting of the author's name, title, year, journal name, publisher, number of citations, article link, and related URL. Table 1 shows examples of publication data used in the VOSviewer analysis, and the sample data taken are the 10 best articles with the highest number of citations.

Table 1
Publication data regarding the citizen science project in learning

No	Authors	Title	Year	Cites	Refs
1	McKinley *et al.,*	Citizen science can improve conservation science, natural resource management, and environmental protection	2017	538	[26]
2	Riesch, H and Potter, C	Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions	2014	240	[27]
3	Kobori *et al.,*	Citizen science: a new approach to advance ecology, education, and conservation	2016	214	[28]
4	Willi *et al.,*	Identifying animal species in camera trap images using deep learning and citizen science	2019	157	[29]
5	Cox *et al.,*	Defining and Measuring Success in Online Citizen Science: A Case Study of Zooniverse Projects	2015	98	[30]
6	Fink *et al.,*	Modelling avian full annual cycle distribution and population trends with citizen science data	2020	74	[31]
7	Cappa *et al.,*	Bring them aboard: rewarding participation in technology-mediated citizen science projects	2018	46	[32]
8	Clavijo *et al.,*	Differential reporting of biodiversity in two citizen science platforms during COVID-19 lockdown in Colombia	2021	33	[33]
9	Nelms *et al.,*	The role of citizen science in addressing plastic pollution: Challenges and opportunities	2022	16	[34]
10	Johnston *et al.,*	Outstanding challenges and future directions for biodiversity monitoring using citizen science data	2023	15	[35]

3.2 Research Developments Regarding the Citizen Science Project

Table 2 shows the trend of research-related publication citizen science project from 2014 to 2023, where 423 articles were published in Scopus-indexed journals. The number of articles in 2014 was 5 articles. In 2015 there were 10 articles; in 2016 there were 23 articles published; in 2017 there were 25 articles; in 2018 there were 37 articles published; in 2019 there were 52 articles; in 2020 there were 82 articles; in 2021 There were 8 articles published totalling 86 articles, and this was the highest number of articles compared to other years. In 2022 there were 79 articles, and in 2023 there were 24 articles.

Table 2
Research development citizen science project

Year of Publication	Number of Publications
2014	5
2015	10
2016	23
2017	25
2018	37
2019	52
2020	82
2021	86
2022	79
2023	24
Total	423
Average	42,3

The level of research development of the citizen science project is quite fluctuating as seen in Figure 2. A significant increase in article publications can be seen from 2020 to 2022, where in 2021 the number published was 82 articles. A decrease in the number of publications was seen in 2022-2023, namely 86 publications, and decreased in 2023 by 24 publications. The data shows that research trends regarding citizen science project tends to be unstable, and in 2023 there has not been an increase in the number of publications.

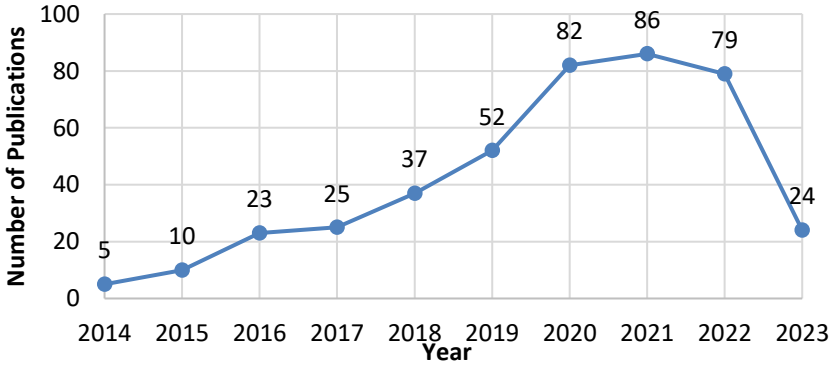

Fig. 2. Level of research development citizen science project

A significant increase in the number of articles can be seen from 2020 to 2022, where in 2021 the number published was 82 articles, in 2022 published 86 articles, and in 2023 published 79 articles. The analysis results show great research interest in citizen science project, especially those related to human health, the environment and the existence of certain animals. Increased publication citizen science project related to the environment and the existence of animals; this was research carried out before the covid-19 pandemic. Meanwhile, according to research trends during the covid-19 period, research showed that citizen science project related to health has increased [36].

Based on the analysis, 96 countries published research results on citizen science project, and there are the ten most productive countries published about citizen science project. The data in Figure 3 shows that the United Kingdom and the United States occupy the highest positions, with 121 and 133 articles. The results of the analysis show that people are motivated to participate in citizen science project activities to help other people so they can collaborate, and apart from that, they can help wild animals at risk of extinction [37]. Figure 3 shows that Indonesia still needs to be included in these 10 countries so that in Indonesia there are still opportunities to increase research regarding citizen science projects, including in learning process activities.

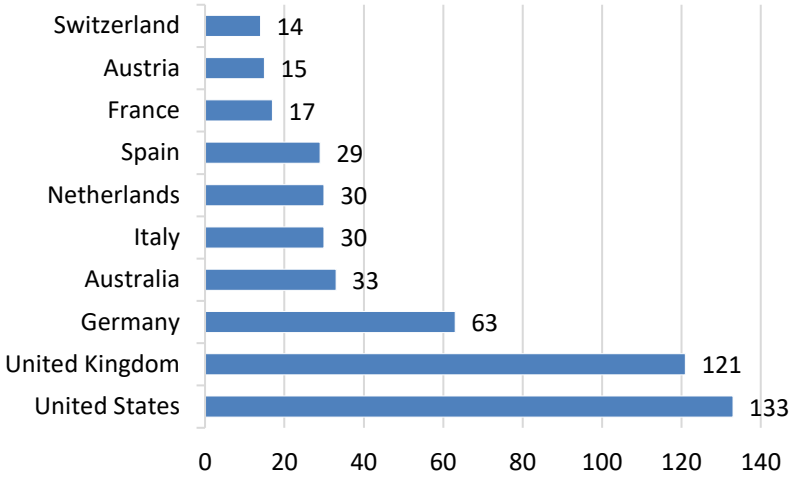

Fig. 3. Publication of citizen science project in ten countries

Figure 4 shows a visualization of the citizen science project keyword network. Data obtained from the Scopus database with a minimum number of occurrences of 5 keywords out of 172 keywords, there are 61 keywords divided into 8 clusters. Cluster 1 is red, consisting of 15 items on conservation and biodiversity. Conservation activities require scientific data and involvement with the wider community, including non-professional volunteers [38]. Apart from that, citizen science assists in monitoring biodiversity data both regionally and globally, improving conservation outcomes by building scientific knowledge and inspiring the public [39,40].

Cluster 2 in green consists of 12 items that focus on citizen scientists. Citizen science is an internal activity that carries out data collection on scientifically based research, and in this activity every community member can participate as a named researcher citizen scientist. Citizen scientists can take part in training before collecting data in the field and collaborate with scientists to contribute to collecting, analysing, and interpreting data regarding biodiversity [41]. Apart from that, it is very important to pay attention to the intrinsic and extrinsic motivation of student citizen scientist so that it can foster interest in getting involved and supporting the research process [42].

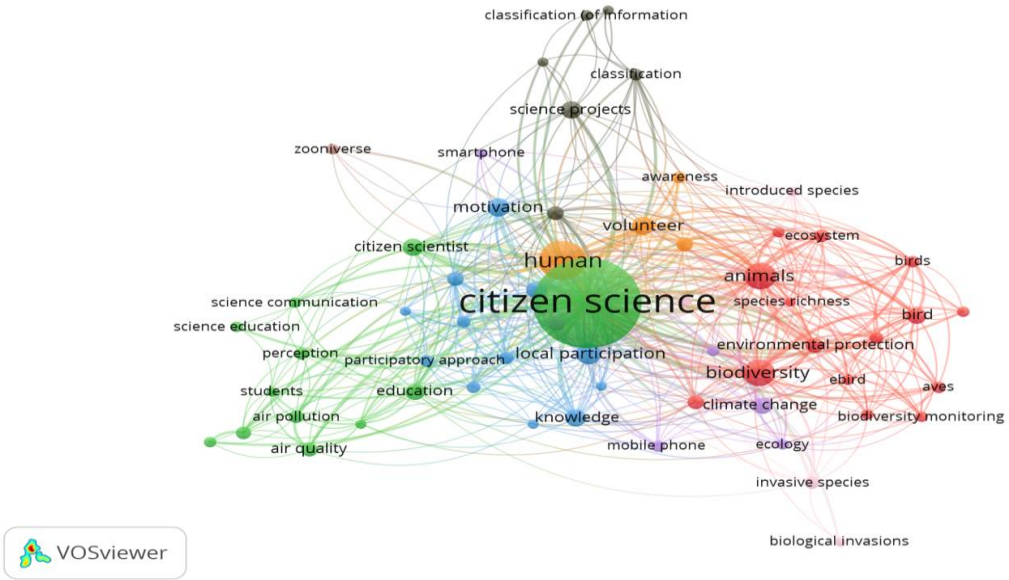

Fig. 4. Visualization of the citizen science project keyword network

Cluster 3 in blue consists of 12 items focusing on community research participation. The public can participate as researchers in the program citizen science project through collaboration with expert researchers so that they will get information about the data being researched. The community collects observational data as a research database that can be used and analysed to reveal important information [43].

Cluster 4 in black consists of 6 items that focus on species classification. Species classification is carried out by referring to groups of organisms that are physically similar. The diversity of species in nature is necessary to obtain data on species groups. Data collection on species can be carried out jointly between citizen scientists who collaborate with experts [44].

Cluster 5 is purple which consists of 6 items that focus on technology use. Technology is an important element that has been widely used in education so that learning becomes effective and efficient [45-48]. The use of technology has helped many community activities in various fields. Citizen science project-technology assistance makes it easier to collect data on species to be studied, such as to find out data on the abundance of mammals in need of supporting equipment in the form of program eMammals by using a camera trapping which can be used effectively to detect the presence of mammals [49]. Additionally, the application on smartphones. It is also often used to determine the presence of certain species, such as applications Spotteron which is used to determine species' existence, especially regarding the condition of dead vertebrate animals on the streets [50].

Cluster 6 in pink contains 5 items that focus on species identification. Identifying a particular species can be done through citizen science project with the help of technology such as smartphone applications [51-53]. Data from observations on species identification can be obtained through collaboration between communities with the same goals and are concerned about the increasing extinction of species in various places.

Cluster 7 in orange consists of 4 items that focus on awareness of preserving the environment. The environment is everything around humans and is reciprocally interconnected, so it must be preserved so that the state of nature remains balanced. This must be done together with community participation and carried out sustainably. Citizen science can support sustainable development, including reducing environmental pollution and climate change. It can also increase public awareness and provide opportunities to contribute to achieving other goals [54].

Cluster 8 in brown consists of 1 item that focuses on the zooniverse. Zooniverse is a web-based platform for citizen science projects that can connect scientists and volunteers in research who can help carry out data analysis and identify images found. Limited time and space in the learning process can use a web-based online system as a support [55]. Zooniverse can provide a number of standard task features, including drawing, asking questions, surveys, and text that can be combined to form complex workflows in citizen science project activities [56].

Results density visualization Figure 5 shows that the brighter the colour and larger the letters that make up an item, the more frequently the item is researched in a research topic [57]. The mapping results show that the keywords that have been input are on average dim green with a small text size. This visualization indicates that research using these keywords is still limited, so research regarding citizen science projects can still be developed with several keywords and linked to other dependent variables in the research that will be conducted.

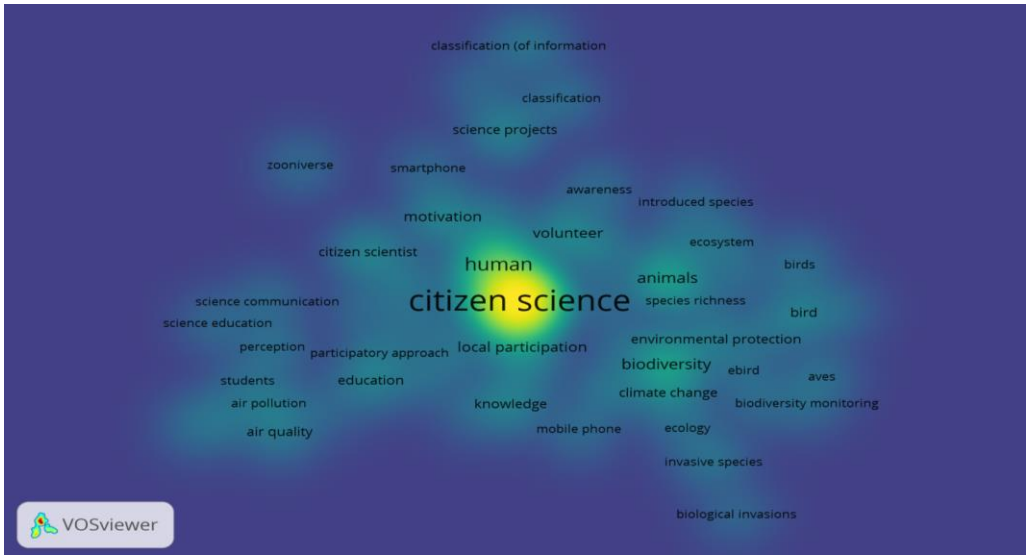

Fig. 5. Density visualization citizen science project

The overlay visualization in Figure 6 shows that the keywords 'citizen science', 'human', 'motivation', 'biodiversity', and 'animals' are often discussed by researchers, and this can be seen from the size of the large ball shape. Keywords with circles and larger letters indicate a lot of research has been carried out, and the darker colour of the circle indicates that research has often been carried out, whereas the brighter the colour circle in the visualization overlay, the more recent the development of research on citizen science [58]. Based on this, research opportunities regarding citizen science can be increased by researching based on related keywords that are coloured light green and bright yellow.

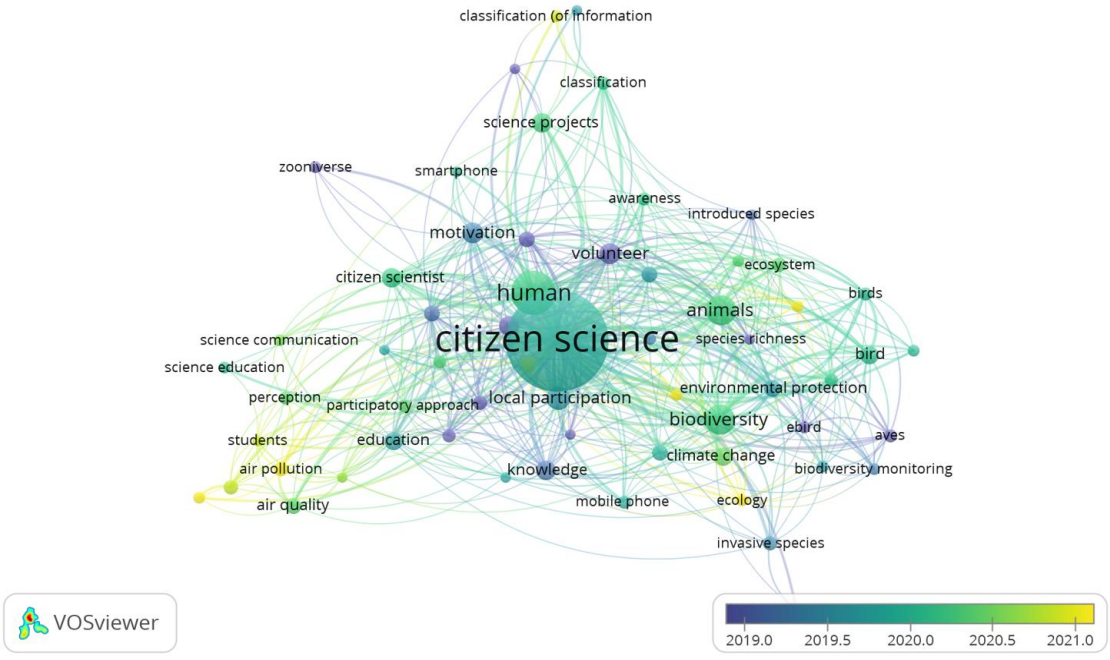

Fig. 6. Overlay visualization citizen science project

4. Conclusions

This bibliometric analysis provides a worldwide overview of research regarding citizen science project. Citizen science projects provide students and the general public opportunities to participate as citizen scientists and contribute to scientific research. Research on citizen science projects continues to increase yearly, which is analysed by connecting keywords. The analysis shows that this can be used as a reference for conducting further research regarding citizen science projects, especially in the field of Biology education.

Acknowledgement

This research was funded by Beasiswa Pendidikan Indonesia (BPI) through the Doctoral Study Completion Scholarship Program.

References

[1] Aristeidou, Maria, Julia Lorke, and Nashwa Ismail. "Citizen science: Schoolteachers' motivation, experiences, and recommendations." *International Journal of Science and Mathematics Education* 21, no. 7 (2023): 2067-2093. https://doi.org/10.1007/s10763-022-10340-z

[2] Bonney, Rick, Caren B. Cooper, Janis Dickinson, Steve Kelling, Tina Phillips, Kenneth V. Rosenberg, and Jennifer Shirk. "Citizen science: a developing tool for expanding science knowledge and scientific literacy." *BioScience* 59, no. 11 (2009): 977-984. https://doi.org/10.1525/bio.2009.59.11.9

[3] Tsortanidou, Xanthippi, Thanasis Daradoumis, and Elena Barberá. "Connecting moments of creativity, computational thinking, collaboration and new media literacy skills." *Information and Learning Sciences* 120, no. 11/12 (2019): 704-722. https://doi.org/10.1108/ILS-05-2019-0042

[4] Danielle L, Lauren J, Elizabeth S. "Citzen Science." (2018).

[5] Roche, Joseph, Laura Bell, Cecília Galvão, Yaela N. Golumbic, Laure Kloetzer, Nieke Knoben, Mari Laakso *et al.,* "Citizen science, education, and learning: Challenges and opportunities." *Frontiers in Sociology* 5 (2020): 613814. https://doi.org/10.3389/fsoc.2020.613814

[6] Paradise, Christopher, and Louisa Bartkovich. "Integrating Citizen Science with Online Biological Collections to Promote Species and Biodiversity Literacy in an Entomology Course." *Citizen Science: Theory & Practice* 6, no. 1 (2021). https://doi.org/10.5334/cstp.405

[7] Burgess, Hillary K., L. B. DeBey, H. E. Froehlich, Natalaie Schmidt, Elli J. Theobald, Ailene K. Ettinger, Janneke HilleRisLambers, Joshua Tewksbury, and Julia K. Parrish. "The science of citizen science: Exploring barriers to use as a primary research tool." *Biological Conservation* 208 (2017): 113-120. https://doi.org/10.1016/j.biocon.2016.05.014

[8] Aripin, I., and T. Hidayat. "Public perception in Majalengka (Indonesia) toward citizen science concept." In *Journal of Physics: Conference Series*, vol. 1521, no. 4, p. 042095. IOP Publishing, 2020. https://doi.org/10.1088/1742-6596/1521/4/042095

[9] El Mohadab, Mohamed, Belaid Bouikhalene, and Said Safi. "Bibliometric method for mapping the state of the art of scientific production in Covid-19." *Chaos, Solitons & Fractals* 139 (2020): 110052. https://doi.org/10.1016/j.chaos.2020.110052

[10] Aria, Massimo, and Corrado Cuccurullo. "bibliometrix: An R-tool for comprehensive science mapping analysis." *Journal of informetrics* 11, no. 4 (2017): 959-975. https://doi.org/10.1016/j.joi.2017.08.007

[11] Bouchard, Louise, Marcelo Albertini, Ricardo Batista, and Joanne De Montigny. "Research on health inequalities: a bibliometric analysis (1966–2014)." *Social Science & Medicine* 141 (2015): 100-108. https://doi.org/10.1016/j.socscimed.2015.07.022

[12] Chen, Ying, Xiaojun Zhang, Shixiang Chen, Yanwen Zhang, Yulu Wang, Qi Lu, and Yue Zhao. "Bibliometric analysis of mental health during the COVID-19 pandemic." *Asian journal of psychiatry* 65 (2021): 102846. https://doi.org/10.1016/j.ajp.2021.102846

[13] Fan, Jingchun, Ya Gao, Na Zhao, Runjing Dai, Hailiang Zhang, Xiaoyan Feng, Guoxiu Shi *et al.,* "Bibliometric analysis on COVID-19: a comparison of research between English and Chinese studies." *Frontiers in public health* 8 (2020): 477. https://doi.org/10.3389/fpubh.2020.00477

[14] Gao, Ya, Long Ge, Shuzhen Shi, Yue Sun, Ming Liu, Bo Wang, Yi Shang, Jiarui Wu, and Jinhui Tian. "Global trends and future prospects of e-waste research: a bibliometric analysis." *Environmental Science and Pollution Research* 26 (2019): 17809-17820. https://doi.org/10.1007/s11356-019-05071-8

[15] Kraus, Sascha, Hongbo Li, Qi Kang, Paul Westhead, and Victor Tiberius. "The sharing economy: a bibliometric analysis of the state-of-the-art." *International journal of entrepreneurial behavior & research* 26, no. 8 (2020): 1769-1786. https://doi.org/10.1108/IJEBR-06-2020-0438

[16] Mao, Guozhu, Ning Huang, Lu Chen, and Hongmei Wang. "Research on biomass energy and environment from the past to the future: A bibliometric analysis." *Science of The Total Environment* 635 (2018): 1081-1090. https://doi.org/10.1016/j.scitotenv.2018.04.173

[17] Zhu, Junwen, and Weishu Liu. "A tale of two databases: The use of Web of Science and Scopus in academic papers." *Scientometrics* 123, no. 1 (2020): 321-335. https://doi.org/10.1007/s11192-020-03387-8

[18] Effendi, Denti Nanda, Welly Anggraini, Agus Jatmiko, Henita Rahmayanti, Ilmi Zajuli Ichsan, and Md Mehadi Rahman. "Bibliometric analysis of scientific literacy using VOS viewer: Analysis of science education." In *Journal of Physics: Conference Series*, vol. 1796, no. 1, p. 012096. IOP Publishing, 2021. https://doi.org/10.1088/1742-6596/1796/1/012096

[19] Prahani, B. K., B. Jatmiko, T. Amelia, M. C. Pristianti, S. Mahtari, and R. F. R. Uulaa. "Web Learning Research in Physics Education During the COVID-19 Pandemic." In *Journal of Physics: Conference Series*, vol. 2392, no. 1, p. 012002. IOP Publishing, 2022. https://doi.org/10.1088/1742-6596/2392/1/012002

[20] Hudha, Muhammad Nur, Ida Hamidah, Anna Permanasari, Ade Gafar Abdullah, Indriyani Rachman, and Toru Matsumoto. "Low Carbon Education: A Review and Bibliometric Analysis." *European Journal of Educational Research* 9, no. 1 (2020): 319-329. https://doi.org/10.12973/eu-jer.9.1.319

[21] Fitriyani, Fitriyani, Antomi Saregar, Yuberti Yuberti, Imam Syafe'i, and Syafrimen Syafrimen. "Trends, opportunities, and challenges of E-learning in physics: A bibliometric literature review." In *AIP Conference Proceedings*, vol. 2595, no. 1. AIP Publishing, 2023. https://doi.org/10.1063/5.0123689

[22] Özçınar, H. "Bibliometric analysis of computational thinking." *Educational Technology Theory & Practice* 7, no. 2 (2017): 149-171.

[23] Sidiq, Muhaemin. "Panduan analisis bibliometrik sederhana." *Universitas Negeri Jakarta. doi* 10 (2019).

[24] Westby, Carol. "Resource review." *Word of Mouth* 32, no. 5 (2021): 10-12. https://doi.org/10.1177/10483950211008345b

[25] Van Eck, Nees Jan, and Ludo Waltman. "Measuring scholarly impact." *Measuring Scholarly Impact* (2014): 285-320. https://doi.org/10.1007/978-3-319-10377-8_13

[26] McKinley, Duncan C., Abe J. Miller-Rushing, Heidi L. Ballard, Rick Bonney, Hutch Brown, Susan C. Cook-Patton, Daniel M. Evans *et al.,* "Citizen science can improve conservation science, natural resource management, and environmental protection." *Biological conservation* 208 (2017): 15-28. https://doi.org/10.1016/j.biocon.2016.05.015

[27] Riesch, Hauke, and Clive Potter. "Citizen science as seen by scientists: Methodological, epistemological and ethical dimensions." *Public understanding of science* 23, no. 1 (2014): 107-120. https://doi.org/10.1177/0963662513497324

[28] Kobori, Hiromi, Janis L. Dickinson, Izumi Washitani, Ryo Sakurai, Tatsuya Amano, Naoya Komatsu, Wataru Kitamura *et al.,* "Citizen science: a new approach to advance ecology, education, and conservation." *Ecological research* 31 (2016): 1-19. https://doi.org/10.1007/s11284-015-1314-y

[29] Willi, Marco, Ross T. Pitman, Anabelle W. Cardoso, Christina Locke, Alexandra Swanson, Amy Boyer, Marten Veldthuis, and Lucy Fortson. "Identifying animal species in camera trap images using deep learning and citizen science." *Methods in Ecology and Evolution* 10, no. 1 (2019): 80-91. https://doi.org/10.1111/2041-210X.13099

[30] Cox, Joe, Eun Young Oh, Brooke Simmons, Chris Lintott, Karen Masters, Anita Greenhill, Gary Graham, and Kate Holmes. "Defining and measuring success in online citizen science: A case study of Zooniverse projects." *Computing in Science & Engineering* 17, no. 4 (2015): 28-41. https://doi.org/10.1109/MCSE.2015.65

[31] Fink, Daniel, Tom Auer, Alison Johnston, Viviana Ruiz-Gutierrez, Wesley M. Hochachka, and Steve Kelling. "Modeling avian full annual cycle distribution and population trends with citizen science data." *Ecological Applications* 30, no. 3 (2020): e02056. https://doi.org/10.1002/eap.2056

[32] Cappa, Francesco, Jeffrey Laut, Maurizio Porfiri, and Luca Giustiniano. "Bring them aboard: Rewarding participation in technology-mediated citizen science projects." *Computers in Human Behavior* 89 (2018): 246-257. https://doi.org/10.1016/j.chb.2018.08.017

[33] Sánchez-Clavijo, Lina María, Sindy Jineth Martínez-Callejas, Orlando Acevedo-Charry, Angélica Diaz-Pulido, Bibiana Gómez-Valencia, Natalia Ocampo-Peñuela, David Ocampo *et al.,* "Differential reporting of biodiversity in two citizen science platforms during COVID-19 lockdown in Colombia." *Biological Conservation* 256 (2021): 109077. https://doi.org/10.1016/j.biocon.2021.109077

[34] Nelms, Sarah E., Emily Easman, Nichola Anderson, Madeleine Berg, Sue Coates, Abigail Crosby, Sonja Eisfeld-Pierantonio *et al.,* "The role of citizen science in addressing plastic pollution: Challenges and opportunities." *Environmental Science & Policy* 128 (2022): 14-23. https://doi.org/10.1016/j.envsci.2021.11.002

[35] Johnston, Alison, Eleni Matechou, and Emily B. Dennis. "Outstanding challenges and future directions for biodiversity monitoring using citizen science data." *Methods in Ecology and Evolution* 14, no. 1 (2023): 103-116. https://doi.org/10.1111/2041-210X.13834
[36] Bian, Shelly X., and Eugene Lin. "Competing with a pandemic: Trends in research design in a time of Covid-19." *Plos one* 15, no. 9 (2020): e0238831. https://doi.org/10.1371/journal.pone.0238831
[37] Pateman, Rachel Mary, Alison Dyke, and Sarah Elizabeth West. "The diversity of participants in environmental citizen science." *Citizen Science: Theory and Practice* (2021). https://doi.org/10.5334/cstp.369
[38] Forrester, Tavis D., Megan Baker, Robert Costello, Roland Kays, Arielle W. Parsons, and William J. McShea. "Creating advocates for mammal conservation through citizen science." *Biological Conservation* 208 (2017): 98-105. https://doi.org/10.1016/j.biocon.2016.06.025
[39] Chandler, Mark, Linda See, Kyle Copas, Astrid MZ Bonde, Bernat Claramunt López, Finn Danielsen, Jan Kristoffer Legind *et al.,* "Contribution of citizen science towards international biodiversity monitoring." *Biological conservation* 213 (2017): 280-294. https://doi.org/10.1016/j.biocon.2016.09.004
[40] Rowley, Jodi JL, Corey T. Callaghan, Timothy Cutajar, Christopher Portway, Kathy Potter, Stephen Mahony, Dane F. Trembath, Paul Flemons, and Adam Woods. "FrogID: Citizen scientists provide validated biodiversity data on frogs of Australia." *Herpetological Conservation and Biology* 14, no. 1 (2019): 155-170.
[41] Rowley, Jodi JL, Corey T. Callaghan, Timothy Cutajar, Christopher Portway, Kathy Potter, Stephen Mahony, Dane F. Trembath, Paul Flemons, and Adam Woods. "FrogID: Citizen scientists provide validated biodiversity data on frogs of Australia." *Herpetological Conservation and Biology* 14, no. 1 (2019): 155-170.
[42] Larson, Lincoln R., Caren B. Cooper, Sara Futch, Devyani Singh, Nathan J. Shipley, Kathy Dale, Geoffrey S. LeBaron, and John Y. Takekawa. "The diverse motivations of citizen scientists: Does conservation emphasis grow as volunteer participation progresses?." *Biological Conservation* 242 (2020): 108428. https://doi.org/10.1016/j.biocon.2020.108428
[43] Tiago, Patrícia, Henrique M. Pereira, and César Capinha. "Using citizen science data to estimate climatic niches and species distributions." *Basic and Applied Ecology* 20 (2017): 75-85. https://doi.org/10.1016/j.baae.2017.04.001
[44] Krabbenhoft, Corey A., and Donna R. Kashian. "Citizen science data are a reliable complement to quantitative ecological assessments in urban rivers." *Ecological Indicators* 116 (2020): 106476. https://doi.org/10.1016/j.ecolind.2020.106476
[45] Masrom, Maslin, Mohd Nazry Ali, Wahyunah Ghani, and Amirul Haiman Abdul Rahman. "The ICT implementation in the TVET teaching and learning environment during the COVID-19 pandemic." *International Journal of Advanced Research in Future Ready Learning and Education* 28, no. 1 (2022): 43-49.
[46] Joli, Nurul Suzaina, Azizah Mohd Zahidi, Kamarul Zaman Hamzah, Noorsyakina Simin, Fairuz Adlidna Badrol Hissam, Mohd Effendi, and Ewan Mohd Matore. "Application of MS Excel Software in The Teaching and Learning of Anova Topic through Google Meet." *Journal of Advanced Research in Computing and Applications* 34, no. 1 (2024): 19-27.
[47] Jaafar, Nurulaini, Siti Rohani Mohd Nor, Siti Mariam Norrulashikin, Nur Arina Bazilah Kamisan, and Ahmad Qushairi Mohamad. "Increase students' understanding of mathematics learning using the technology-based learning." *International Journal of Advanced Research in Future Ready Learning and Education* 28, no. 1 (2022): 24-29.
[48] Jamaludin, Nabila Farhana, and Siti Farahin Sedek. "CANVA as a Digital Tool for Effective Student Learning Experience." *Journal of Advanced Research in Computing and Applications* 33, no. 1 (2023).
[49] McShea, William J., Tavis Forrester, Robert Costello, Zhihai He, and Roland Kays. "Volunteer-run cameras as distributed sensors for macrosystem mammal research." *Landscape Ecology* 31 (2016): 55-66. https://doi.org/10.1007/s10980-015-0262-9
[50] Heigl, Florian, Kathrin Horvath, Gregor Laaha, and Johann G. Zaller. "Amphibian and reptile road-kills on tertiary roads in relation to landscape structure: using a citizen science approach with open-access land cover data." *BMC ecology* 17 (2017): 1-11. https://doi.org/10.1186/s12898-017-0134-z
[51] Marshall, David J., Ahmed Awad Abdelhady, Dennis Ting Teck Wah, Nurshahida Mustapha, Stefan H. Gödeke, Liyanage Chandratilak De Silva, and Jason M. Hall-Spencer. "Biomonitoring acidification using marine gastropods." *Science of the total environment* 692 (2019): 833-843. https://doi.org/10.1016/j.scitotenv.2019.07.041
[52] Kelemen-Finan, Julia, Martin Scheuch, and Silvia Winter. "Contributions from citizen science to science education: an examination of a biodiversity citizen science project with schools in Central Europe." *International Journal of Science Education* 40, no. 17 (2018): 2078-2098. https://doi.org/10.1080/09500693.2018.1520405
[53] Andrew, Carrie, Einar Heegaard, Paul M. Kirk, Claus Bässler, Jacob Heilmann-Clausen, Irmgard Krisai-Greilhuber, Thomas W. Kuyper *et al.,* "Big data integration: Pan-European fungal species observations' assembly for addressing contemporary questions in ecology and global change biology." *Fungal Biology Reviews* 31, no. 2 (2017): 88-98. https://doi.org/10.1016/j.fbr.2017.01.001

[54] Fritz, Steffen, Linda See, Tyler Carlson, Mordechai Haklay, Jessie L. Oliver, Dilek Fraisl, Rosy Mondardini *et al.,* "Citizen science and the United Nations sustainable development goals." *Nature Sustainability* 2, no. 10 (2019): 922-930. https://doi.org/10.1038/s41893-019-0390-3

[55] Umar, Norazah, Nurhafizah Ahmad, Jamal Othman, and Rozita Kadar. "Investigating students' acceptance of e-learning effectiveness: A case study in higher education." *Journal of Advanced Research in Computing and Applications* 18, no. 1 (2020): 1-10.

[56] Smith, Patricia, Oliver NF King, Avery Pennington, Win Tun, Mark Basham, Martin L. Jones, Lucy M. Collinson, Michele C. Darrow, and Helen Spiers. "Online citizen science with the Zooniverse for analysis of biological volumetric data." *Histochemistry and Cell Biology* 160, no. 3 (2023): 253-276. https://doi.org/10.1007/s00418-023-02204-6

[57] Nandiyanto, Asep Bayu Dani, and Dwi Fitria Al Husaeni. "A bibliometric analysis of materials research in Indonesian journal using VOSviewer." *Journal of Engineering Research* (2021).

[58] Maryanti, R. I. N. A., N. I. Rahayu, M. Muktiarni, D. F. Al Husaeni, A. C. H. M. A. D. Hufad, S. Sunardi, and ASEP BAYU DANI Nandiyanto. "Sustainable development goals (SDGs) in science education: Definition, literature review, and bibliometric analysis." *Journal of Engineering Science and Technology* 17 (2022): 161-181.