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# Does Citizen Science Reach the Citizen? Exploring the Science–Society Interface Through Scholarly and Societal Attention

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The study applied an Altmetric approach to examine the science-society interface in citizen science research. Bibliographic data were collected from Scopus for 10,285 articles published between 2016 and 2025. Altmetric data corresponding to the 100 most highly cited articles were collected from the Dimensions database. Python was used for various statistical analyses. Spearman's ρ was computed to assess the association between scientific impact and social influence. Mann-Whitney U test was used to analyze how open access (OA) status affected scholarly and social constructs. The results showed 2017 having the highest number of publications (23) and citations (8,172). Altmetric Attention Score (AAS) was highest in 2018 (5,093). The articles spanned across 73 journals and 57 countries, with the US being the most productive. X was the most prominent among social media platforms. Correlations among citations, AAS, and Mendeley were found to be weak to moderate (ρ=0.437 for Citation-AAS, ρ=0.570 for Citation-Mendeley, and ρ=0.350 for AAS-Mendeley). OA status of articles significantly increased AAS but not citations or Mendeley readership. The relation between scientific impact and societal attention of citizen science research was relatively close, yet enough distinction remained. The results would benefit researchers, journals, funders, and practitioners of citizen science.



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## Introduction

The facets of 'science' have been transformed with various digital changes (Bello & Galindo-Rueda, 2020). This transition led to a shift from closed academic systems to open knowledge ecosystems (Costa & Matias, 2020). Updated digital infrastructures enabled public participation and collaborative knowledge production. A rapid rise has been observed in participatory 'citizen science' and diverse public engagement (Chilvers & Kearnes, 2020). Citizen science democratizes science by combining professional and amateur science, diverse public and community activities (Strasser et al., 2018; Tolbert et al., 2025). It redefined scientific 'authority' and knowledge production. It challenged the existing boundary between experts and the lay public (Giardullo, 2023; Zakharov & Shishkova, 2025). Sustainability, governance, and other fields have widely recognized its importance (Sauermann et al., 2019; Turrini et al., 2018).

### *Citizen Science as a Socio-Scientific Paradigm*

The 'citizen science' evolved from scattered lay contributions to a methodologically diverse research model. The term first appeared in the 1990s with Alan Irwin and Rick Bonney (Follett & Strezov, 2015; Pelacho et al., 2021). Since its emergence, the term has complemented different aspects of public participation in science. Multiple studies have shown an exponential growth in "citizen science" publications across biology, conservation, ecology, geography, the social sciences, and health (Kullenberg & Kasperowski, 2016; Pocock et al., 2017). Early models of citizen science claimed it to be contributory, where volunteers used to participate in data collection only (Dickinson et al., 2012; Fraisl et al., 2022). Later on, collaborative models of citizen science introduced citizens to assist in other areas of research (Senabre Hidalgo et al., 2021; Van De Gevel et al., 2020). The extension of digital platforms has maximized the scale and style of participation (Newman et al., 2012). Moreover, research infrastructures have shifted from technical tools to socio-technical systems (e.g., citizen observatories and platforms) (Soacha-Godoy, López-Borrull, et al., 2025; Soacha-Godoy, Prakash, et al., 2025). Overall, it extended beyond data collection to generating knowledge. This enables the participation of civilians in science (Bonney et al., 2016).

### *Citizen Science and the Science–Society Interface*

Citizen science bridges academic science and its cultural context. It helps align research with societal and policy needs (Austen et al., 2024). The translation of knowledge between experts and non-experts is integrated into citizen science (Heinisch, 2020). Citizen science enhances communication between science and society (Wagenknecht et al., 2021). Citizen science legitimately produced knowledge. Thus, it aided science, which was in crisis of trust (Skarlatidou et al., 2024). Participation fosters ownership of results and claims fair research. Therefore, citizen science strengthens the social embedding of scientific knowledge (Hecker et al., 2019; Woolley et al., 2016).

### *Limits of Traditional Impact Measurement*

Citation-based indicators have become the de facto drivers of research evaluation (Belter, 2015; Butler et al., 2017; Jappe, 2020). These indicators are useful for assessing the impact of research on the scientific community alone (Mfengu & Raju, 2024). This creates an "academic echo chamber" where work is optimized for citations (Crompton, 2025; Ozanne et al., 2017). It does not indicate the usefulness of research to society. Traditional metrics lack the potential to measure the complex, long-term societal influence (Bornmann, 2017; Rau et al., 2018). They only measure the peer-to-peer impact (Greenhalgh et al., 2016). Furthermore, citation databases mostly lack data on public engagement. Therefore, it is under-reported in impact studies (Lammons et al., 2025; Russell et al., 2020; Staley, 2015).

### *Role of Altmetrics in Capturing Societal Attention*

The understanding of Altmetrics (alternative metrics) emerged around 2010 (Erdt et al., 2016; Schlierkamp et al., 2025). It aimed to track web-based attention to research across platforms (Ali, 2021). Thus, it offers a faster and broader view than traditional citations (Taylor, 2023). Altmetrics count digital mentions, saves, views, and discussions as measures of societal attention to research (García-Villar, 2021). These measures are aggregated to a composite indicator, AAS (Altmetric Attention Score) (Elmore, 2018). Table 1 depicts various dimensions of Altmetrics and how Altmetrics capture them.

**Table 1.** Dimensions of societal attention in Altmetrics

| Dimension | Methods of Capture |
|---|---|
| Public and media attention | Mentions on online platforms indicate how widely the research has gained attention on social networks and media (R. F. Araujo, 2020; Cao et al., 2023; Ma et al., 2022). |
| Dissemination of knowledge | Cross-platform assessment reveals how research has been disseminated beyond journals (Fang et al., 2020; K.Sharp et al., 2025). |
| Policy and practice uptake | Altmetrics link cross-disciplinary research and media visibility to policy use (Dorta-González et al., 2024; Mullins et al., 2023; Pinheiro et al., 2021) |

However, Altmetrics only measure the public attention, not the quality of the research. Therefore, it only complements citation rather than replacing it (Regan & Henchion, 2019).

Prior discussions already established that the central concept of citizen science is public participation. Therefore, only measuring scholarly impact is not sufficient. Integration of Altmetrics would assist in analyzing the overall research landscape in citizen science. Therefore, the present study aimed to capture the social influence of scientifically valued research on citizen science. Altmetric assessments revealed societal visibility and public engagement associated with these research.

## Review of Literature

### *Computational mapping on citizen science*

Multiple studies have been reviewed to understand how they applied computational mapping of scientific literature on citizen science. Different bibliometric studies e.g., (Barui & Mazumder, 2023; Kullenberg & Kasperowski, 2016; Pelacho et al., 2021) identified a massive increase in the volume of literature on citizen science in the last decade. (Castagneyrol et al., 2023) used bibliometrics to compare ecology related studies with and without applying citizen science. The results showed that research themes were significantly different in those two categories. (Alfaro-Ponce et al., 2024) conducted a bibliometric study of articles on citizen science as educational strategies. (Wu & Benaglia, 2024) also applied bibliometric techniques to assess papers on citizen science in education. (Wang & Ma, 2025) performed a bibliometric study on the application of citizen science in waterbird conservation. The study found different changes in thematic phases of the domain. (González-Teruel & Abad-García, 2026) evaluated seven different search strategies in the Web of Science. The study further emphasized the need for specialized controlled vocabulary. These studies focused on applying bibliometric studies on literature on citizen science.

### *Altmetric studies in related fields*

The study reviewed various altmetric studies to understand how the technique has been applied to the literature of related fields. (Peng & Chen, 2024) applied a combination of bibliometric and altmetric techniques to the top

100 most-cited articles on religion. (Yu & Chen, 2025) applied a similar technique to assess literature on social psychology. The findings showed a weak relationship between social and academic impact. (G & Babu B K, 2024) assessed the correlation between citation and AAS of top 100 highly-cited articles in health information management journals. The study found that academic citations and social media mentions do not have a strong association. (Araujo et al., 2021) found multiple variables associated with altmetric scores, including the open access status of articles. However, the study did not examine open access status as a differentiator between scholarly and societal attention with a statistical test.

### *Research gap*

It was observed that existing literature conducted bibliometric techniques to evaluate the research landscape on citizen science. But the altmetric approach remained very limited. However, altmetric methods have been increasingly used in other fields to assess the public attention to high-impact research. Citizen science addresses public participation as its central idea. Therefore analyzing public attraction to its high-impact research becomes non-negotiable. The present study addresses this gap by analyzing the social attention received by the most highly cited research on citizen science. Thus, the study aimed to provide an overview of the interface between science and society in citizen science.

## Objectives

1. To analyze the year-wise growth of publications, citations, and AAS of the top 100 highly cited articles on citizen science,
2. To identify the most productive journals and countries contributing to these citizen science research,
3. To investigate the dissemination patterns of these high impact publications in various social media and online platforms,
4. To measure the association between citation counts, AAS, and Mendeley readership among these highly cited publications,
5. To examine whether open access (OA) status is associated with differential scholarly and societal attention

## Methodology

An altmetric technique has been used to measure the science–society interface in citizen science research. 100 articles with the highest citation counts constituted the scope of the study. Figure 1 represents the methodological workflow followed in this study.

### *Data collection*

The study collected the required data for the analysis in two phases. In the first phase, the study collected bibliographic data of highly cited papers from Scopus. The coverage of Scopus is broad and curated, making it a credible source of bibliographic data (Baas et al., 2020; Ballew, 2009; De Moya-Anegón et al., 2007; Powell & Peterson, 2017; Schotten et al., 2017). It was accessed on 30.08.2026. An initial search query was constructed using terms related to citizen science. The query was executed using the title, abstract, and keywords (TITLE-ABS-KEY) field. It returned a total of 19,597 records. Furthermore, the year of publication (PUBYEAR) was limited to 2016-2025. Additionally, the type of source (SRCTYPE) and document (DOCTYPE) were limited to journals and articles, respectively. Only articles published in the English language were selected. After applying these filters, the final query returned 10,285 results and is as follows:

TITLE-ABS-KEY ( "citizen science" OR "public participation in scientific research" OR "PPSR" OR "civic science" OR "participatory science" OR "amateur science" OR "crowd-sourced science" OR "crowdsourced science" OR "crowdsourcing science" OR "crowdsourcing research" OR "crowd science" OR "collaborative science" OR "community science" OR "volunteer monitoring" OR "volunteer-based monitoring" OR "volunteer thinking" OR "volunteer computing" OR "participatory sensing" OR "crowdfunding science" OR "contributory science" ) AND ( LIMIT-TO ( DOCTYPE , "ar" ) ) AND ( LIMIT-TO ( LANGUAGE , "English" ) ) AND ( LIMIT-TO ( SRCTYPE , "j" ) ) AND PUBYEAR > 2015 AND PUBYEAR < 2026

The 10,285 records were exported in a .csv file with the following metadata fields: Authors, Author full names, Author(s) ID, Title, Year, Source title, Volume, Issue, Art. No., Page start, Page end, Page count, Cited by, DOI, Link, Affiliations, Authors with affiliations, Abstract, Author Keywords, Index Keywords, Molecular Sequence Numbers, Chemicals/CAS, Funding, Texts, References, Editors, Publisher, Sponsors, Conference name, Conference date, Conference location, Conference code, ISSN, ISBN, CODEN, PubMed ID, Language of Original Document, Document Type, Publication Stage, Open Access, Source, and EID.

The exported .csv file was arranged in descending order of 'Cited by' to retrieve the most highly cited papers on citizen science.

In the next phase, the study collected altmetric data corresponding to the 100 most highly cited papers using the Dimensions database. The database provides a comprehensive set of altmetric data for published articles (Herzog et al., 2020; Hook et al., 2018). It was also accessed on 30.08.2026 between 12 pm and 4 pm. DOIs were used to match each of the top 100 records to its corresponding Dimensions record. The data for each article were retrieved manually. 2 articles were found to have missing Altmetric data. Therefore, they were excluded, and the immediate next 2 articles with Altmetric records were incorporated into the scope of the study. The following indicators were collected: AAS, Mendeley, X, Facebook, Reddit, Bluesky, News, Blogs, Wikipedia, Policy documents, Patents, Video, Peer reviews, Google+, CiteULike, F1000, QnA, and Podcasts. Table 2 groups them according to the type of altmetric channel.

**Table 2.** Classification of dissemination and research impact indicators by channel type

| Type of channel | Indicators |
|---|---|
| Composite score | AAS (Altmetric Attention Score) |
| Scholarly reference manager | Mendeley |
| Social media | X, Facebook, Reddit, Bluesky |
| Mass/public media | News, Blogs, Video, Podcasts |
| Knowledge/reference platforms | Wikipedia |
| Policy and applied impact | Policy documents, Patents |
| Peer and scholarly commentary | Peer reviews, F1000, CiteULike, Google+, QnA |

***Data harmonisation and validation***

The study used DOI as the common identifier that connected records in both databases, i.e., Scopus and Dimensions, for a particular publication. This ensured consistent matching across sources. For the preparation of the final altmetric dataset, articles with no recorded activity on a given channel were coded as zero for that channel. They were not treated as missing data. This was done for the smooth functioning of data analysis. However, they should not be interpreted as having actual zero public engagement. Moreover, altmetric data are dynamic. Therefore, the dataset represents a snapshot as of the Dimensions pull date. Additionally, the results of the study should be interpreted for the highest-impact citizen science research. The validity of the findings should not be generalized for the whole field.

***Data analysis***

The study used various libraries of Python (3.9.6) for different analyses. Pandas (2.3.3) was used to handle data. Numeric operations were performed using NumPy (2.0.2). To conduct statistical tests, SciPy (1.13.1) was employed. Bonferroni correction was conducted with statsmodels (0.14.6). Matplotlib (3.9.4) was used to make all kinds of visualizations. The study conducted different non-inferential analyses. This includes assessing temporal growth, identifying the most productive journals and countries, and analysing top articles based on AAS and Mendeley. Furthermore, patterns of dissemination of articles across platforms were also evaluated. Spearman's rank correlation coefficient ($\rho$) was calculated to test the association between citation counts, AAS, and Mendeley readership counts. The purpose was to measure the monotonic association between them, rather than establish causation. A five-band scale, as described in (Schober et al., 2018) was used to interpret the correlation (see Table 3). Moreover, the study analyzed the differences between Open Access and subscription-based articles in citation counts, AAS, and Mendeley readership. Mann-Whitney U test was conducted for this purpose. Across all statistical tests, $\alpha = 0.05$ served as the baseline significance threshold, with the Bonferroni-adjusted threshold of $\alpha \approx 0.0167$ applied specifically.

**Table. 3** Direction and range of Spearman correlation coefficient ($\rho$) strengths

| Absolute magnitude of the observed correlation coefficient | Interpretation |
|---|---|

| | |
|---|---|
| ± 0.00–0.10 | Negligible correlation |
| ± 0.10–0.39 | Weak correlation |
| ± 0.40–0.69 | Moderate correlation |
| ± 0.70–0.89 | Strong correlation |
| ± 0.90–1.00 | Very strong correlation |

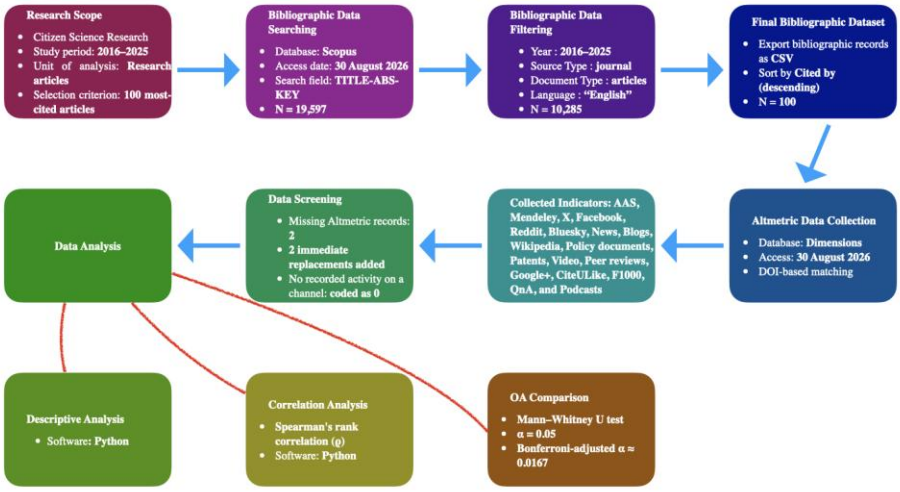



**Figure 1.** Methodological workflow for assessing the science–society interface in highly cited citizen science research

## Data Analysis and Interpretation

### *Chronological growth of articles, citations, and AAS*

Table 4 illustrates the year-wise distributions of publications, citations, and AAS of articles published between 2016 and 2025. Figure 2 presents a graphical representation of the chronological growth of these distributions. 2024 and 2025 were found with zero publications that came under the most highly cited 100 articles. However, this was not an error in the data and the pattern is very common. Recent articles have less time to accumulate enough citations to enter a 'most highly cited' ranking yet (Pérez-Campdesuñer et al., 2025; Stern, 2014). The highest number of articles was published in 2017 (23). It also received the highest total citations (8,172). However, 2018 had the highest AAS (5,093) despite having fewer articles (16) and citations (4,545) than 2017. 2021 received the highest average AAS (485.4), more than 5 times that of 2020 (83.2). However, only 10 articles were published in 2021. This spike in the AAS occurred possibly because public interest in participatory science increased in the pandemic era. Citizen science research was already well-established since the start of the window. Therefore its growth in volume does not follow public emergence like any technology driven field (e.g., deepfakes) (Chakraborty & Verma, 2026).

**Table 4.** Chronological growth pattern of Articles (NP), Citations (TC), and Altmetric Attention Scores (AAS)

| Year | NP | TC | AAS | Average Citations | Average AAS |
|---|---|---|---|---|---|
| 2016 | 16 | 5617 | 1112 | 351.1 | 69.5 |
| 2017 | 23 | 8172 | 3128 | 355.3 | 136 |

| | | | | | |
|---|---|---|---|---|---|
| 2018 | 16 | 4545 | 5093 | 284.1 | 318.3 |
| 2019 | 14 | 3878 | 851 | 277 | 60.8 |
| 2020 | 14 | 3428 | 1165 | 244.9 | 83.2 |
| 2021 | 10 | 3518 | 4854 | 351.8 | 485.4 |
| 2022 | 6 | 1703 | 905 | 283.8 | 150.8 |
| 2023 | 1 | 212 | 59 | 212 | 59 |
| 2024 | 0 | 0 | 0 | 0 | 0 |
| 2025 | 0 | 0 | 0 | 0 | 0 |

Note: Avg. Citations = TC/NP, Avg. AAS = AAS/NP

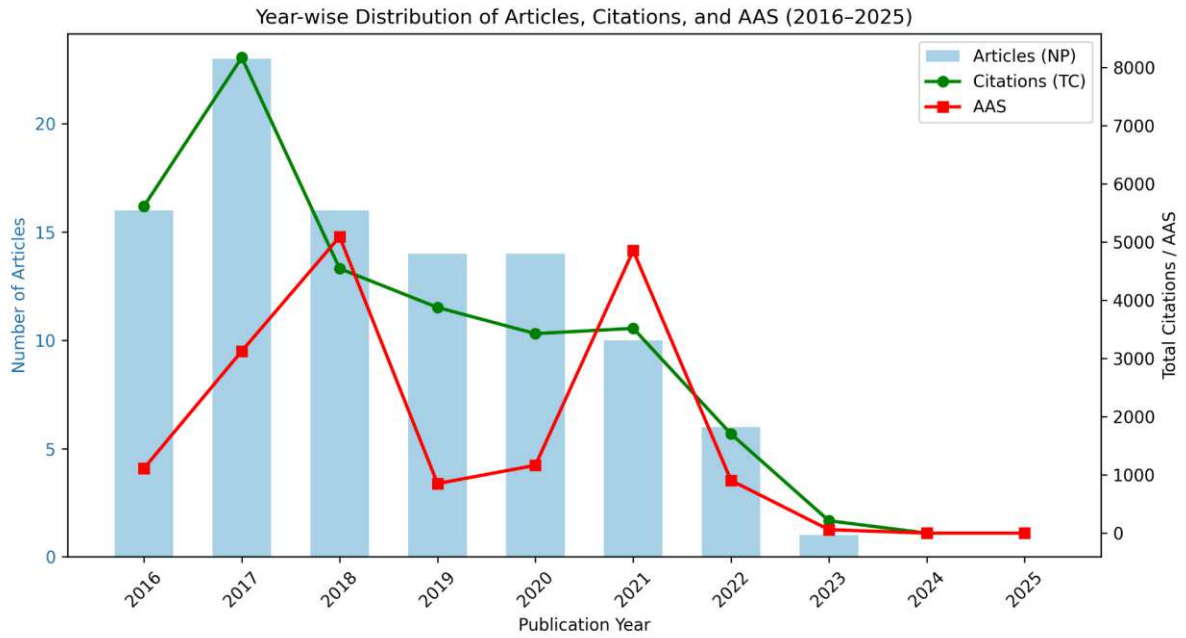



**Figure 2.** Chronological growth pattern of Publications, Citations, and AAS. The bar plot illustrates the year-wise growth of Number of Publications (NP); the line graphs indicate the year-wise growth of Citations (TC) and AAS.

***Most productive journals***

A total of 73 journals published the most highly cited 100 articles on citizen science. Therefore the distributions of these articles in journals were not concentrated. Table 5 lists the top ten most productives of them. "Biological Conservation" leads the table with 6 articles. It has 2,709 citations, an AAS of 379, and a Mendeley Readership count (MR) of 5,418. Despite having the highest citations and MR among the top 10, its AAS was comparatively low. "BioScience" was the second most productive journal with 5 publications. It received a total of 1,218 citations, 426 AAS, and 1,625 MR. It was followed by "Marine Pollution Bulletin" (4 articles). The journal had 1,027 citations, 206 AAS, and 2,211 MR. "Scientific Reports" had by far the highest AAS (1,472) in the top 10 most productive journals. However, it held the rank 4th in productivity (3 articles). This indicates that higher productivity in journals does not always guarantee greater social media attention. It was also observed that the table was mostly dominated by domain specific journals related to biology, environment, and ecology. However the existence of journals like "Public Understanding of Science" states that citizen science is studied as a form of public engagement.

**Table 5.** Most productive journals.

| Rank | CiteScore | Source title | NP | TC | AAS | MR |
|---|---|---|---|---|---|---|
| 1 | 7.6 | Biological Conservation | 6 | 2709 | 379 | 5418 |
| 2 | 14.4 | BioScience | 5 | 1218 | 426 | 1625 |
| 3 | 9.7 | Marine Pollution Bulletin | 4 | 1027 | 206 | 2211 |
| 4 | 6.4 | Scientific Reports | 3 | 1105 | 1472 | 1708 |
| 5 | 24.3 | Nature Communications | 3 | 909 | 541 | 1026 |
| 6 | 12.7 | Methods in Ecology and Evolution | 3 | 710 | 154 | 1197 |
| 7 | 10.1 | Conservation Biology | 3 | 568 | 76 | 1232 |
| 8 | 7.2 | Public Understanding of Science | 2 | 1131 | 147 | 2250 |
| 9 | 19 | Environment International | 2 | 1078 | 73 | 1557 |
| 10 | 4.8 | PLoS ONE | 2 | 864 | 387 | 1380 |

Note: NP = Number of Publications, TC = Total Citations, AAS = Altmetric Attention Scores, MR = Mendeley Readership counts

***Most productive countries***

The authors of the most highly cited 100 papers on citizen science were from 57 different countries. Table 6 depicts the top ten most productive countries. A complete counting method was used by giving one credit to each author's respective country (Huang et al., 2011). The US published a total of 62 articles and topped the table. Another scientometric study also found the US as the most productive in citizen science research (Barui & Mazumder, 2023). It also accumulated the highest number of citations (19,863), MR (34,150), and AAS (12,100). It was followed by the UK which also published the second most articles (36) and received the second most citations (11,880), MR (20,480), and AAS (9,867). It was observed that the authors of the most highly cited articles on citizen science were predominantly from the global-north countries.

**Table 6.** Most productive countries.

| Rank | Country | NP | TC | MR | AAS |
|---|---|---|---|---|---|
| 1 | United States | 62 | 19863 | 34150 | 12100 |
| 2 | United Kingdom | 36 | 11880 | 20480 | 9867 |
| 3 | Germany | 22 | 6240 | 11626 | 4948 |
| 4 | Australia | 18 | 5945 | 11102 | 5445 |
| 5 | Netherlands | 14 | 4760 | 9844 | 3591 |
| 6 | Sweden | 13 | 3740 | 8055 | 3142 |
| 7 | France | 12 | 4048 | 6803 | 3690 |
| 8 | Switzerland | 11 | 3489 | 6130 | 2858 |

| | | | | | |
|---|---|---|---|---|---|
| 9 | Canada | 10 | 3905 | 6247 | 3945 |
| 10 | Austria | 10 | 3535 | 6900 | 1216 |

Note: Country-level indicators are based on complete counting, country-level totals may exceed the dataset-wide totals. NP = Number of Publications, TC = Total Citations, AAS = Altmetric Attention Scores, MR = Mendeley Readership counts

***Most impactful publications based on AAS and Mendeley Readership***

The study further identified the articles with highest AAS and Mendeley Readership (see Tables 7 and 8). Thus the tables list the top ten most impactful publications, along with their year of publication and publishing journals. “American Gut: An open platform for citizen science microbiome research” by Vázquez-Baeza Y. et al. received the highest AAS (2,470). The study provided a platform for citizen science research on microbiome. On the other hand, “Citizen science can improve conservation science, natural resource management, and environmental protection” by McKinley D.C. et al. received the highest MR (1,806). The article was foundational and attempted to define the field. This indicates why the article gained high readership counts on Mendeley. Three articles co-exist in both the tables, i.e., Vázquez-Baeza Y. et al., Silberzahn R. et al., and Troudet J. et al. This co-existence indicates that these articles gained both high scholarly readership and high public attention.

The study also attempted to construct some thematic clusters of these articles using a focused qualitative assessment. The analysis was conducted based on the titles of each article. The following clusters were identified: Health & Patient-Driven Citizen Science (Vázquez-Baeza Y. et al., Callard F. et al., Beatty A.L. et al., Barzilay R. et al.), Biodiversity Conservation and Monitoring (Zattara E.E. et al., Mayor S.J. et al., Heberling J.M. et al., Hughes A.C. et al., Chandler M. et al.), Conceptual Overviews (McKinley D.C. et al., Bonney R. et al.), Data Quality & Methodology (Kosmala M. et al., Troudet J. et al., Silberzahn R. et al., Tennant J.P. et al.), and Environmental Sensing and Education (Castell N. et al., Paul J. et al.). It was observed that articles from “Health & Patient-Driven Citizen Science” and “Biodiversity Conservation and Monitoring” clusters tend to gain high AAS. While health related citizen science gained direct human interest, biodiversity related papers were highly attractive on online media. On the other hand, Articles from “Conceptual Overviews” and “Data Quality & Methodology” clusters gathered high MR. This was driven by the researchers of citizen science who read these articles on Mendeley while designing their studies. Therefore, high social attention to citizen science was caused by the attractiveness of the studies and high scholarly engagement was driven by the methodological utility of the paper.

**Table 7.** Top 10 publications ranked by Altmetric Attention Scores (AAS)

| Rank | Title | Authors | Year | Journal | AAS |
|---|---|---|---|---|---|
| 1 | American Gut: An open platform for citizen science microbiome research | Vázquez-Baeza Y. et al. | 2018 | mSystems | 2470 |
| 2 | Many analysts, one data set: Making transparent how variations in analytic choices affect results | Silberzahn R. et al. | 2018 | Advances in Methods and Practices in Psychological Science | 2019 |
| 3 | How and why patients made Long Covid | Callard F. et al. | 2021 | Social Science and Medicine | 1751 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | Worldwide occurrence records suggest a global decline in bee species richness | Zattara E.E. et al. | 2021 | One Earth | 1240 |
| 5 | Increasing phenological asynchrony between spring green-up and arrival of migratory birds | Mayor S.J. et al. | 2017 | Scientific Reports | 960 |
| 6 | Analysis of COVID-19 Vaccine Type and Adverse Effects Following Vaccination | Beatty A.L. et al. | 2021 | JAMA Network Open | 515 |
| 7 | Data integration enables global biodiversity synthesis | Heberling J.M. et al. | 2021 | Proceedings of the National Academy of Sciences of the United States of America | 466 |
| 8 | Taxonomic bias in biodiversity data and societal preferences | Troudet J. et al. | 2017 | Scientific Reports | 436 |
| 9 | The academic, economic and societal impacts of Open Access: An evidence-based review | Tennant J.P. et al. | 2016 | F1000Research | 325 |
| 10 | Sampling biases shape our view of the natural world | Hughes A.C. et al. | 2021 | Ecography | 321 |

**Table 8.** Top 10 publications ranked by Mendeley readership counts (MR)

| Rank | Title | Authors | Year | Journal | Mendeley |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 1 | Citizen science can improve conservation science, natural resource management, and environmental protection | McKinley D.C. et al. | 2017 | Biological Conservation | 1806 |
| 2 | Can citizen science enhance public understanding of science? | Bonney R. et al. | 2016 | Public Understanding of Science | 1501 |
| 3 | Can commercial low-cost sensor platforms contribute to air quality monitoring and exposure estimates? | Castell N. et al. | 2017 | Environment International | 1219 |
| 4 | Contribution of citizen science towards international biodiversity monitoring | Chandler M. et al. | 2017 | Biological Conservation | 1177 |
| 5 | Many analysts, one data set: Making transparent how variations in analytic choices affect results | Silberzahn R. et al. | 2018 | Advances in Methods and Practices in Psychological Science | 1149 |
| 6 | Resilience, COVID-19-related stress, anxiety and depression during the pandemic in a large population enriched for healthcare providers | Barzilay R. et al. | 2020 | Translational Psychiatry | 1087 |
| 7 | Assessing data quality in citizen science | Kosmala M. et al. | 2016 | Frontiers in Ecology and the Environment | 1033 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | Taxonomic bias in biodiversity data and societal preferences | Troudet J. et al. | 2017 | Scientific Reports | 1030 |
| 9 | American Gut: An open platform for citizen science microbiome research | Vázquez-Baeza Y. et al. | 2018 | mSystems | 971 |
| 10 | A Comparative Analysis of Student Performance in an Online vs. Face-to-Face Environmental Science Course From 2009 to 2016 | Paul J. et al. | 2019 | Frontiers in Computer Science | 969 |

***Dissemination pattern of research on citizen science through online media***

The dissemination patterns of most highly cited 100 papers on citizen science across various platforms were evaluated (see Table 9). These papers accumulated a total of 31,073 citations, 17167 AAS, and 53,335 Mendeley Readerships. They showed substantial engagement on both scholarly and public-facing channels. Mendeley was the most dominant channel by a wide margin. Among the social media platforms, X was the most dominant, receiving 10,893 mentions. This relatively stable ratio between mentions in Mendeley and X states that citizen science had a built-in non-academic audience, i.e., citizen scientists themselves. They might share and discuss this research on X. Facebook received only 226 mentions, unevenly distributed across the years. Another social media platform, Reddit showed high concentrations in 2018 (99) and 2021 (106). This same pattern was observed at a lesser quantity for Bluesky. News, blogs, and Wikipedia showed moderate public-facing disseminations, 1,067, 209, and 111, respectively. Podcast activities were highly concentrated in 2018 with 39 mentions, far above any other year. This was probably driven by specific high podcast-value papers. Papers were mentioned in 166 policy documents. The remaining seven channels together accounted for fewer than 100 total mentions. Recent years (2022 and 2023) have shown drastic decline in almost every indicator. This was probably due to the fact that recent articles had less time to get disseminated across online media.

**Table 9.** The year-wise dissemination pattern of scientific research through social media, mass media, and reference manager platforms

| Year | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | Total |
|---|---|---|---|---|---|---|---|---|---|
| NP | 16 | 23 | 16 | 14 | 14 | 10 | 6 | 1 | 100 |
| TC | 5617 | 8172 | 4545 | 3878 | 3428 | 3518 | 1703 | 212 | 31073 |
| AAS | 1112 | 3128 | 5093 | 851 | 1165 | 4854 | 905 | 59 | 17167 |
| X | 730 | 1321 | 3620 | 605 | 803 | 3054 | 693 | 67 | 10893 |
| Facebook | 52 | 84 | 44 | 15 | 13 | 14 | 4 | 0 | 226 |
| Reddit | 7 | 16 | 99 | 13 | 5 | 106 | 5 | 0 | 251 |
| Bluesky | 2 | 13 | 28 | 2 | 2 | 39 | 10 | 0 | 96 |
| Mendeley | 9538 | 14252 | 7459 | 7411 | 7025 | 4517 | 2777 | 356 | 53335 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| News | 40 | 234 | 300 | 40 | 71 | 334 | 48 | 0 | 1067 |
| Blogs | 39 | 39 | 49 | 13 | 7 | 48 | 12 | 2 | 209 |
| Wikipedia | 31 | 20 | 13 | 7 | 7 | 30 | 3 | 0 | 111 |
| Policy documents | 18 | 53 | 32 | 14 | 20 | 18 | 9 | 2 | 166 |
| Patents | 7 | 4 | 8 | 1 | 5 | 0 | 1 | 0 | 26 |
| Video | 1 | 3 | 25 | 2 | 1 | 4 | 0 | 0 | 36 |
| Peer reviews | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Google+ | 8 | 8 | 2 | 0 | 1 | 0 | 0 | 0 | 19 |
| CiteULike | 5 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 10 |
| F1000 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 3 |
| QnA | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| Podcasts | 3 | 1 | 39 | 1 | 0 | 4 | 0 | 0 | 48 |

Note: NP = Number of Publications, TC = Total Citations, AAS = Altmetric Attention Scores

***Baseline Metric Relationships among Scopus citations, AAS, and Mendeley readership counts***

It was found that the dataset comprising citation counts, Altmetric Attention Scores (AAS), and Mendeley Readership counts was not normally distributed. Moreover, the number of data points was very small (N=100). Therefore, Spearman's rank correlation coefficient (Spearman's ρ) was computed to measure the association between these three variables (see Table 10). The calculated Spearman's ρ was interpreted to measure the effect size for each pair. Two of the observed linear associations were moderate, while the other one was marginally weak. The association between Mendeley and AAS showed the weakest association (ρ=0.350) (Schober et al., 2018). This indicates that public or social attention and scholarly readership are the two most independent and distinct channels. While the former is related to the larger members (i.e., public) of the society, the latter is related to the core scientific community. Citation counts and Mendeley Readership counts exhibited a moderate correlation (ρ=0.570), the strongest association among all the pairs. This stronger association was expected, as both channels are oriented toward the scholarly community. An article tends to have more readership when it gets cited. The association between Citation counts and AAS (ρ=0.437) was weaker than Mendeley-Citation but stronger than AAS-Mendeley. This association was measurably stronger than what earlier studies have found for different fields (Chakraborty & Verma, 2026; Nip & Feng, 2022; Patil et al., 2023). It reveals that citizen science research had a closer but moderate alignment between scholarly impact and public attention. The direct involvement of 'citizen' resulted in more built-in public attention and scholarly impact.

However, none of these associations was strong or very strong. It states that scholarly impact and societal attention are two related yet distinct constructs. Figures 3, 4, and 5 illustrate three scatter plots visualizing the Spearman's correlations between the three variables. The more the dots appear on a straight line in each pair, the stronger the association is. The non-overlapping pattern across all three figures indicates weak-to-moderate associations.

**Table 10.** Spearman's rank correlation among Scopus Citation, AAS, and Mendeley Readership counts

| Variable | Statistic | Citation | AAS | Mendeley |
|---|---|---|---|---|
| Citation | Correlation Coefficient | 1 | 0.437** | 0.570** |
| | Sig. (2-tailed) | | 0 | 0 |
| | N | 100 | 100 | 100 |

| | | | | |
|---|---|---|---|---|
| AAS | Correlation Coefficient | 0.437** | 1 | 0.350** |
| | Sig. (2-tailed) | 0 | | 0 |
| | N | 100 | 100 | 100 |
| Mendeley | Correlation Coefficient | 0.570** | 0.350** | 1 |
| | Sig. (2-tailed) | 0 | 0 | |
| | N | 100 | 100 | 100 |

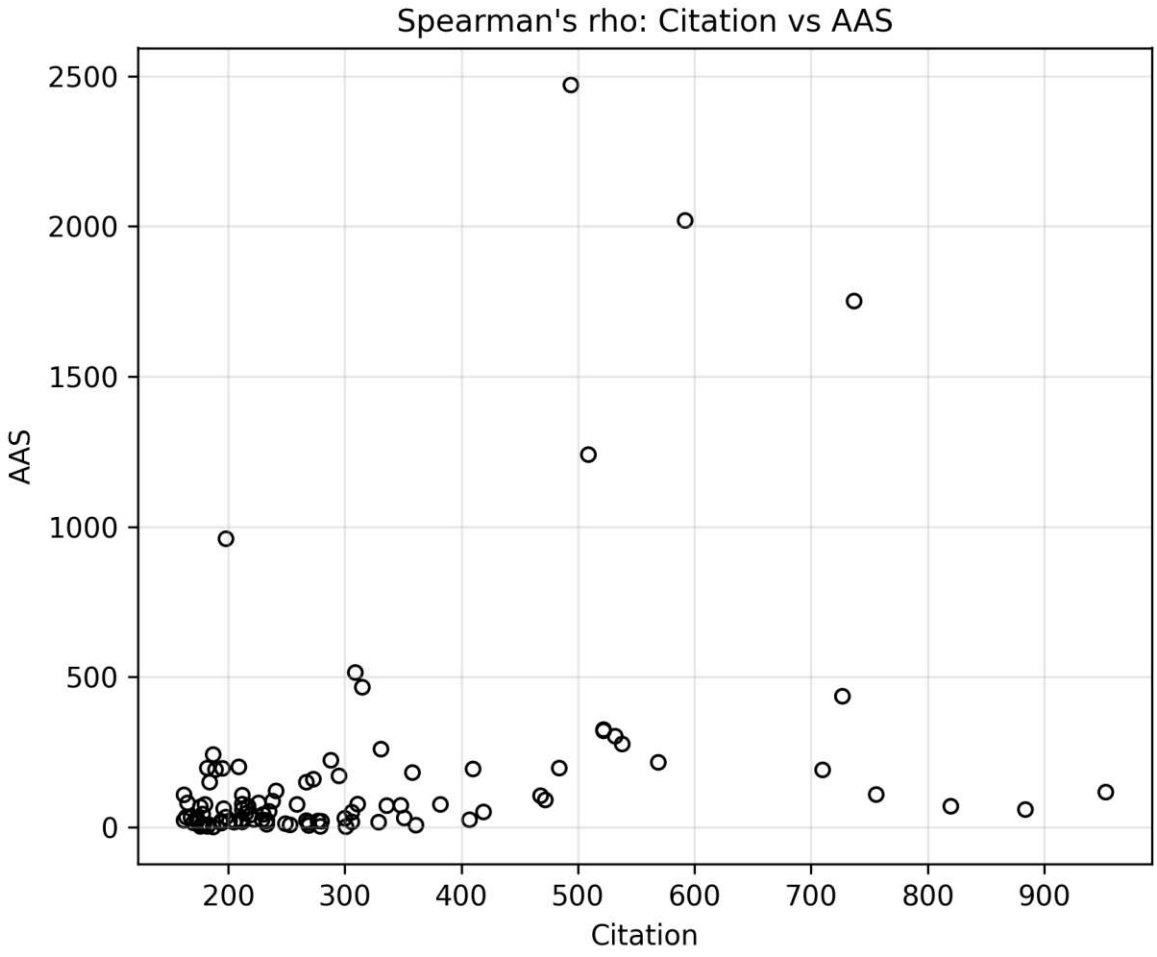



**Figure 3.** Correlation between Citation and AAS

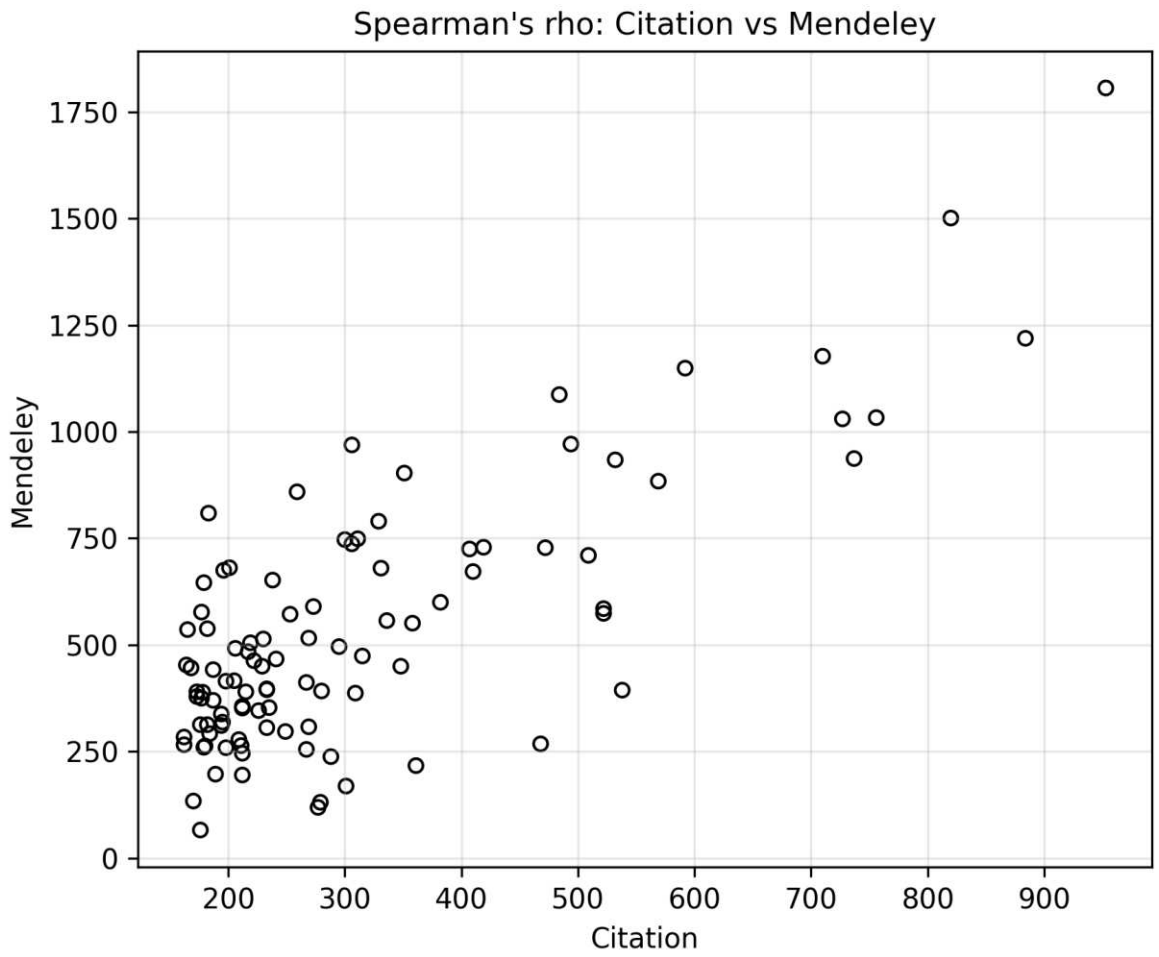



**Figure 4.** Correlation between Citation and Mendeley Readership Counts

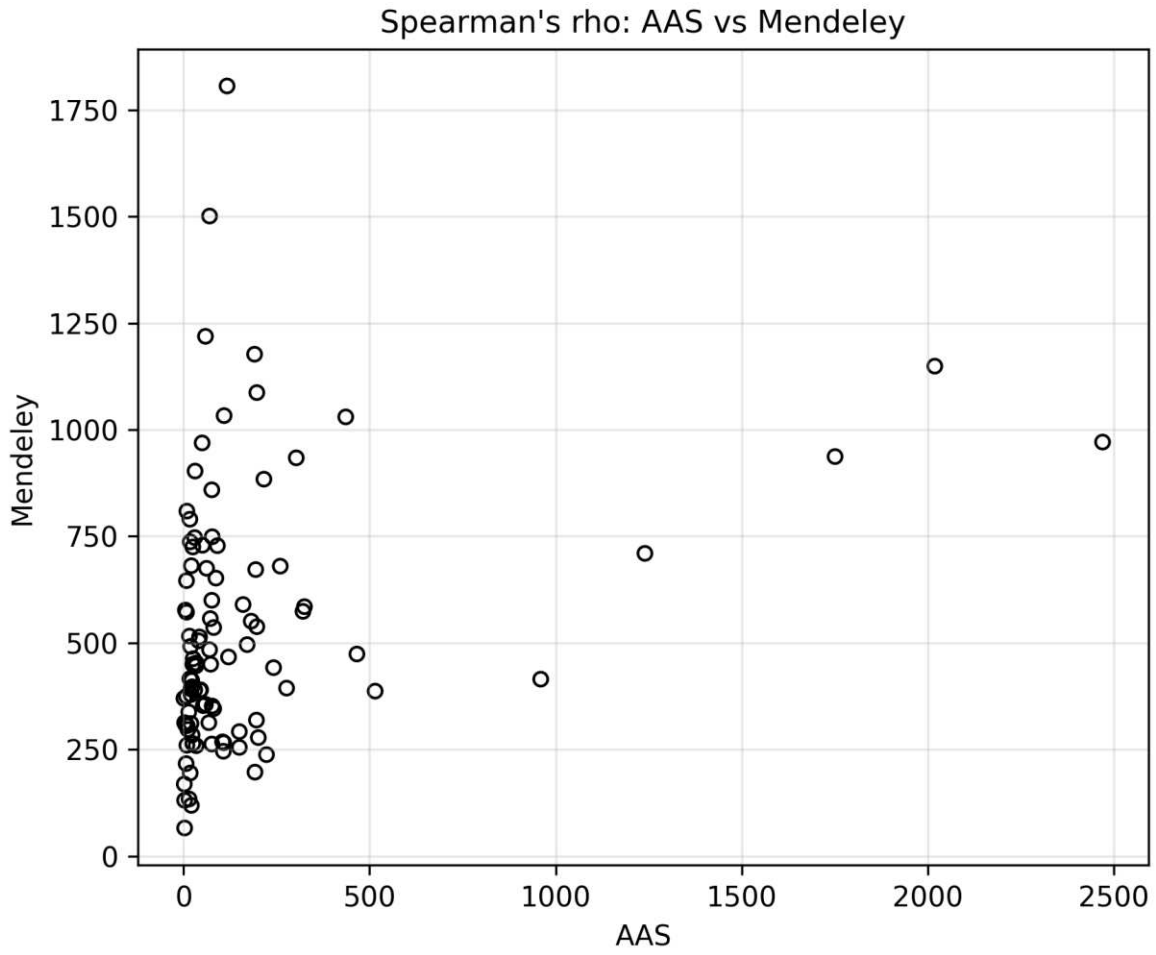



**Figure 5.** Correlation between AAS and Mendeley Readership Counts

***Open Access status and altmetric attention***

The study tested the open access (OA) status of articles against citation counts, AAS, and Mendeley readership. The distributions of these three variables were non-normal. Therefore, Mann-Whitney U test was used to compare citation, AAS, and Mendeley distributions between OA and closed-access papers. It is a rank-based non-parametric test for comparing two independent groups of non-normal distributions (Hart, 2001; Ruxton, 2006). Table 11 illustrates reported medians of the variables as the primary descriptive statistic. A Bonferroni correction was applied to control the error rate. It controls the potential risk of false positives during multiple statistical tests (Armstrong, 2014). It adjusted the significance threshold from $\alpha = 0.05$ to $\alpha \approx 0.0167$. The table reported both raw and corrected p-values. However, significance was measured based on the corrected one. Moreover, rank-biserial correlation was reported alongside each test as a non-parametric effect-size measure.

It was found that 75 out of the 100 most-cited articles were published as open access. There was no relationship found between OA status and citation counts (median: OA = 238.0, Closed = 241.0; U = 1025.5, p = 0.486, corrected p = 1.000, r = −0.094). This indicated that citation behavior among impactful citizen science research is unaffected by paywall status. The plausible explanation is that academic authors typically have institutional access for closed access articles also. OA papers received substantially higher Altmetric Attention Scores than closed-access papers (median: OA = 73.0, Closed = 20.0; U = 1379.5, p < .001, corrected p = 0.0013). Moreover, the effect size was also larger ( r = −0.471, following conventional thresholds of ~0.1 small, ~0.3 medium, ~0.5 large). However, Mendeley readership showed a smaller, non-significant difference

(median: OA = 474.0, Closed = 392.0; U = 1167.5, corrected p = 0.203). The findings showed that highly cited OA articles on citizen science had higher dissemination in social platforms, receiving high AAS. However, they did not influence scholarly impact (citation counts) at a large scale. This was due to institutional access as it largely neutralizes the paywall effect. However, it is also possible that topics likely to attract public attention are independently more likely to be published open access, rather than open access status directly driving attention.

**Table 11.** Mann-Whitney U comparison of citation counts, AAS, and Mendeley readership between Open Access and closed-access publications (Bonferroni-corrected for three comparisons)

| Metric | OA Mean | OA_median | Closed Mean | Closed Median | U | p (raw) | p (Bonferroni) | Rank-biserial r | Significance |
|---|---|---|---|---|---|---|---|---|---|
| Citations | 314.6933333 | 238 | 298.84 | 241 | 1025.5 | 0.4860641332 | 1 | -0.094 | ns |
| AAS | 214.1866667 | 73 | 44.12 | 20 | 1379.5 | 0.0004400007535 | 0.0013 | -0.471 | ** |
| Mendeley | 549.7466667 | 474 | 484.16 | 392 | 1167.5 | 0.06771409571 | 0.2031 | -0.245 | ns |

Note: n = 75 Open Access and 25 Closed access. ns = not significant; ** = significant at α = 0.05 after Bonferroni correction for 3 comparisons.

**Discussion**

The study examined the science-society interface in citizen science research using an altmetric approach on the top 100 most-cited articles published in the last decade (2016-2025). The results revealed that 2017 was the year with the most scientific impact and social attention was at its peak in 2018 and 2021. Impactful articles were concentrated in domain specific journals. However, “Scientific Reports” received the highest public attention among journals. Global-north countries were the most productive, while the US and the UK performed particularly well. This re-established the findings from previous studies and possibly is driven by greater funding available in these countries (Chandler et al., 2017; Deacon et al., 2023; Feldman et al., 2021). Papers with the highest AAS and papers with the highest Mendeley Readership reflected different types of content. Papers on application of citizen science in popular fields like Biodiversity and Health received high social attention (AAS), while conceptual and methodological papers received high scholarly reading (MR). Mendeley and citations dominated total dissemination volume. The study also found the associations between citation counts, AAS, and MR to be weak to moderate. However, citation and AAS correlated better than multiple other fields. The findings also revealed that articles published in open access journals tend to receive significantly higher social attention (AAS), despite scientific impact being unaffected. Overall, scientific impact and social attention were found to remain related but distinct constructs.

***Interpretive synthesis: the science–society interface pattern***

The "science-society interface" sits between citizen science research and its audiences as a set of loosely-correlated mechanisms. For example, the OA status of an article did not affect how much other scientists cite the paper. However, it significantly drove the amount of social attention it received. Moreover, the topic of the paper was still an important factor to attract public attention. Topics with high societal relevance attracted high social attention compared to the conceptual or methodological topics. The journal that published the most high-impact citizen science research, i.e., Biological Conservation, did not gain the most public attention. The country level analysis stated the other way, where the same countries received both high citations and high AAS. Journal-level attention might be driven by specific papers’ content, while country-level attention relied on dozens of papers and authors. The absence of strong correlation between citations and AAS further proved the difference between scholarly and societal attention. However, the correlation was stronger than other fields. Therefore, citizen science research had scientific impact and societal influence in a different pattern, though exhibiting better association than other domains. The social relevance and direct public engagement made the "science-society interface" differentiating yet more related than other fields.

***Platform-specific attention dynamics***

The study explored the holistic dissemination of high impact research on citizen science across different platforms (see Table 9). The channels should be assessed separately to interpret the dissemination patterns rather than interpreting at a common scale. For example, the numerical difference between Mendeley (53,335) and X (10,893) was huge but these two are completely different channels, scholarly reference manager and social media, respectively. Mendeley Readership is relatively more closely connected with conventional scholarly impact (Mohammadi et al., 2015; Zahedi et al., 2017). However, it is not a direct reflection of citation counts as the study found a moderate correlation. Whereas, information related to citizen science has been widely disseminated through the discussions on X (Mazumdar & Thakker, 2020). Both of them showed better performances to disseminate research at their own distinct scales. However, other social media platforms (Facebook, Reddit and Bluesky) exhibited minimal episodic attention. Bluesky had the least dissemination among the social media platforms, as it only became publicly available for open registration in February 2024 (Nogara et al., 2026). Its platform maturity and public recognition are relatively lower than other well-established platforms. Dissemination through policy documents and Wikipedia provides direct evidence of research crossing into applied use and reference knowledge among the public. Among the mass media platforms, News gained significantly high dissemination of citizen science research. This indicates that some highly visible citizen-science research crossed from scholarly communication into mainstream news media. Other forms of channels showed either almost negligible public attention or very episodic attention corresponding to specific years. Therefore, their relevance to high impact citizen science research remains an open question.

***Implications***

The results of the study would assist researchers, publishers, funders, and practitioners make more informed decisions. The researchers of citizen science may consider publishing in OA journals to make their research better disseminated and gain more public attention. Domain specific journals that seek public attention might look at what drives AAS in journals like “Scientific Reports”. The study also suggests that the funders should not rely on citation counts alone to assess the “broader impact" of citizen science grants as scientific and social impact were not strongly correlated. The practitioners of citizen science seeking public participation should choose topics wisely as topics of popular interest gained better societal reach than purely foundational topics. Overall, the study offers comprehensive evidence for evaluating the field's contribution to both science and society.

**Conclusion**

After evaluating the science-society interface in high-impact citizen science research (2016-2025), the study found that scientific impact and societal influence are related but consistently distinct constructs. The study found that high-impact OA articles on citizen science tend to have more social attention, whereas it does not significantly affect scientific impact. Additionally, the association between citations and AAS was moderate, yet stronger compared to several comparable fields (e.g., social psychology, deepfake research, anesthesiology). Therefore, citizen science exhibited a better balance between scholarly and societal constructs. It was also observed that attractive applied topics (e.g., health and biodiversity) tend to attract more social attention compared to foundational topics. To the best of the authors' knowledge, this is the first study to apply an altmetric approach at a cross-disciplinary level specifically for citizen science research.

The study has some specific limitations. The scope of the study was explicitly limited to the articles that were indexed in Scopus. Furthermore, only articles with very high scientific visibility (the 100 most cited) were analyzed. Therefore, the results of the study are only relevant to high-impact citizen science research and cannot be generalized to the whole scientific literature on citizen science. Moreover, the altmetric data were collected from a single altmetric database (Dimensions). Additionally, what we considered as “zero” attention reflects only the absence of indexing that particular data. It does not imply no attention at all in a real world scenario. The country-level analysis followed a complete counting method. A normalized counting might provide better insights. Articles might have further online media activities, though the activities might not be indexed in the database. Furthermore, Altmetric indicators are inherently dynamic, and the present dataset reflects a time-bound snapshot. Therefore, the results should be interpreted with caution. The study provided a comprehensive overview of the position of high-impact citizen science research on the science-society interface. This might assist researchers, journals, funders, and practitioners to make more evidence-based decisions.

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