Amsterdam Smart Citizen Lab #1. Credit: Waag Society CC BY-NC-SA 2.0

Citizen Science & Open Science: Synergies & Future Areas of Work

Executive Summary

Citizen Science (CS) and Open Science (OS) are among the most discussed topics in current research and innovation policy, and are becoming increasingly related. This policy brief was developed with contributions from a mixed group of experts from both fields. It aims at informing decision makers who have adopted Citizen Science or Open Science on the synergies between these approaches and the benefits of considering them together. By showcasing initiatives implemented in Europe, this document highlights how Citizen Science and Open Science together can address grand challenges, respond to diminishing societal trust in science, contribute to the creation of common goods and shared resources, and facilitate knowledge transfer between science and society to stimulate innovation. The issues of openness, inclusion and empowerment, education and training, funding, infrastructures and reward systems are discussed regarding critical challenges for both approaches. The document concludes by recommending to consider Citizen Science and Open Science jointly, to strengthen synergies by building on existing initiatives, launching targeted actions regarding education and training, and infrastructures. This policy brief was developed within the framework of the Horizon 2020 project 'Doing It Together Science' (DITOs) to establish a collaborative network with external organisations and decision makers throughout Europe.

Transformations of Research

The ongoing digital revolution has prompted rapid changes in scientific practices and governance. Computer-supported data, tools and technologies are enabling greater potential for both broader access and wider non-expert participation in scientific research and innovation. In this context, Open Science and Citizen Science represent two influential and steadily evolving concepts in research policy and practice that are used differently by various stakeholder groups.

Open Science (OS) is an "umbrella term encompassing a multitude of assumptions about the future of knowledge creation and dissemination", widely applied to e.g. technological infrastructure, accessibility of knowledge creation, access to knowledge, measurement of impact and collaborative research.[1] At the core of OS is the idea of sharing of and throughout the research process. Facets of OS include: Open Access, Open Data, Open Source, Open Hardware, Open Educational Resources, Open Methodology and Open Evaluation.[2] Policy support for OS is increasingly widespread throughout the world.

Citizen Science (CS) refers to the "inclusion of members of the public in some aspect of scientific research", such as co-creating research questions, data collection and analysis or volunteer computing.[3] The field is very diverse and includes multiple forms, depths and aims of collaboration between academic and citizen scientists as well as virtually all scientific disciplines. The European Citizen Science Association (ECSA) puts forward 10 principles of what constitutes good Citizen Science.[4] While interest in CS is booming around the world, the creation of formal support structures remains uneven.

It is critical to note that research projects may have different degrees of both openness and citizen involvement. Thus, policy makers are advised to view them across a spectrum, rather than as binary 'yes or no' conditions[5] :

Links between Citizen Science & Open Science

OS and CS can share concerns, values and outcomes despite their distinct agendas. Recognising such commonalities (see for instance Fig. 1) provides a foundation for designing policies that can simultaneously support both movements.

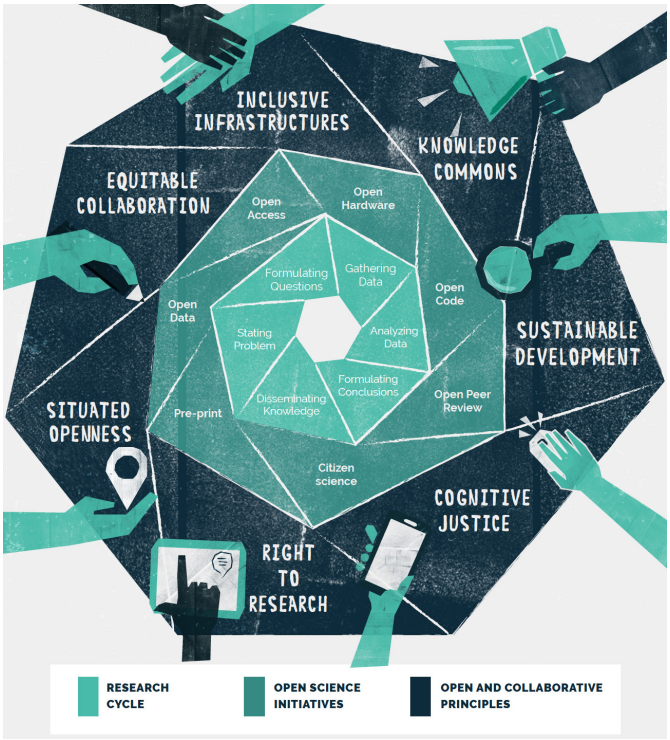

Fig. 1: Principles of Open Collaborative Science from OCSDNet, 2017.[6]

1) How Open Science facilitates Participation

Citizen involvement in research requires at least a basic degree of openness. In projects driven by academia, researchers must communicate with potential participants about the research objectives and expected results of the project in order to motivate engagement.[7] In addition to encouraging participation in projects, increased openness and easy access to researchers, e.g. through social media, *enables a wider public to suggest research topics* that they would like to see scientists address, or joint projects to tackle.

OS furthermore enables CS by giving access to *existing research data and scholarly literature,* which otherwise is likely to be too expensive for citizen scientists when publications are behind a paywall. *Use of open-source hardware and software tools* can also serve to reinforce the accessible nature of educational and data resources generated by CS projects.

2) How Citizen Science enables Openness

Many CS projects make the data they generate accessible to some degree or contribute to the development of *freely (re) usable research tools and methods.* CS projects with *open data sharing and licensing policies* enable citizens to set clearer guidelines on data access corresponding with their motivations (Case study 1).[8]

What is more, CS can generate new perspectives on research subjects. Participatory research projects allow asking questions about the *philosophical and conceptual foundations of the research context*. Instead of accepting the existing ways in which science is articulated, researchers can work with affected groups to design research projects that are suitable for all stakeholders involved (Case study 2).[9]

3) Joint Benefits

Doing Citizen Science and Open Science holds potential benefits for scientific processes as well as society (Fig. 2).

CS and OS both have potential to *address many of the grand challenges of our time* such as social justice, epidemics, emergency response and resilience, environmental monitoring, climate change and sustainable development (Case study 3).[10] Such contributions from CS and OS reinforce the dimensions, agendas and results of Responsible Research and Innovation (RRI). To ensure positive feedback, the practices of CS and OS must themselves become more responsible and innovative, i.e. 'science with and for society'.[11]

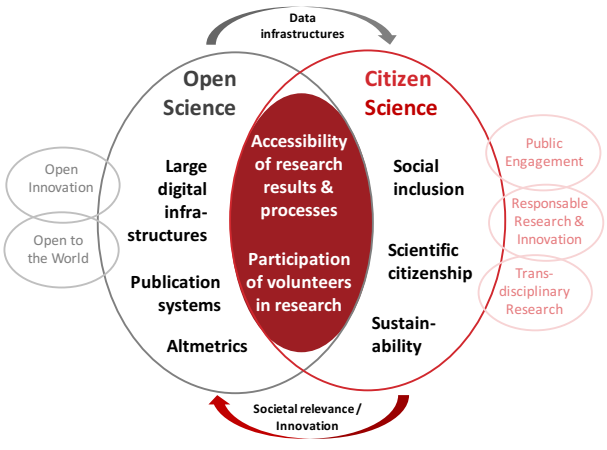

Fig. 2: OS and CS Core Concepts and Areas of Synergy from Vohland & Göbel, 2017.[12]

Case study 1: ExploreAT! - Humanities, natural science and FAIR data

https://exploreat.usal.es/

ExploreAT! is a multidisciplinary open science project that relies on social tools for cultural discovery and preservation of the German language. Using games and novel visual analytics, the project brings together citizens, researchers, heritage institutions, and designers to reveal the rich texture of Bavarian regional dialects.

CS aspect: The project works with dialect natives and global citizens as well as school children and adults, who perform problem crowdsourcing, define the research design and discover new forms of knowledge exchange.

OS aspect: ExploreAT! publishes linked open data that connects lexical, temporal, geographical and historical linguistic features with the global and European knowledge web.

ExploreAT! illustrates an example of a research infrastructure that helps humanities scholars to open up to work with researchers from other disciplines and civil society, generating new research opportunities.

Case study 2: Prototyping a new Heathrow Airport

http://www.softhook.com/heathrow

This initiative involved working with residents living near Heathrow airport to design noise-sensing hardware. Devices installed in their homes and gardens gathered independent evidence of the impact of noise on people and wildlife. The project registered complaints about off-hour flights while gathering a long-term dataset. The data shared with local authorities fed into consultation processes, and was also used to produce local audio soundscapes, which allowed others to hear both the noise and its startling effects on wildlife.

CS aspect: The collaborative design of the project produced better evidence of noise impacts and engaged audiences not directly affected by the flight noise.

OS aspect: The use of open hardware ensured accessibility and long-term availability of the data.

Thus CS and OS can be combined to create forms of evidence that are useful for affected groups, allowing them to challenge environmental and urban development policy when needed.

Linked to this first aspect is the potential to *respond to diminishing societal trust in science*. OS can improve access to scientific results, increase transparency and foster reproducibility of scientific research; CS contributes to the same goals through active participation in research, technology development and innovation and learning about science and technology.

Another important facet of OS and CS is how their initiatives can *contribute to the creation of common goods and shared resources* (Case study 4). Examples include a body of knowledge, methods and tools, or a pool of data that then serve as infrastructures for further research and civic action.

Finally, CS and OS can *facilitate knowledge transfer between science and society to stimulate innovation*. For both approaches, it is common to cross disciplinary boundaries and contribute to knowledge integration between scientific domains. What is more, CS and OS can bring other kinds of expertise to bear on research questions indicating and addressing societal research needs, thus contributing to enable research endeavours that would not be possible otherwise.

Current Status & Future Challenges

Despite many potential synergies, CS and OS are only starting to grow together. While sharing results as openly as possible is considered a quality characteristic of CS, data sharing and interoperability are heterogeneous in practice[13,14]. On the other hand, most Open Science practice does not encompass dedicated efforts to facilitate participation by volunteers without a research background.

Nevertheless, key intersections with CS are becoming increasingly acknowledged in the field of Open Science through efforts like the EU Open Science Police[15] and by communities such as those aorund Wikimedia or Open Knowledge. In the CS field, pilot initiatives are emerging around CS data and metadata interoperability[16], principles for open and reusable software development[17], and the open-access journal "Citizen Science: Theory & Practice".

For moving onwards, the following challenges are central:

Openness

- Improve data management and stewardship for CS.
- Continue work on findability, accessibility, interoperability and reusability of CS data, with examples of implementing FAIR Principles[18]
- Acknowledge different types of contributions to science and find adequate ways of making them visible, traceable and reusable, regardless of whether the CS outputs are data, software or project platforms or something else.
- Work to resolve legal uncertainties and share approaches to intellectual property and licensing issues at the intersection of CS and OS.

Inclusion & Empowerment

- Expand the involvement of CS volunteers beyond data collection and analysis by opening all stages of the research cycle to participation and enabling more co-creation of research results and co-design of research projects.
- Foster equitable and sustainable science.
- Promote global-level dialogue and cooperation between stakeholders.

Education & training

- Include CS in research education and training on OS and vice versa, and include both in general research education and training.
- Ensure means for science education and communication to accompany CS initiatives.
- Build CS and OS into teacher training.

Funding

- Increase and diversify the opportunities for small seed funding for project prototyping and experimentation in CS and OS.
- Offer mechanisms for funding that address the different project characteristics of CS and OS initiatives, such as scoping phases for co-design of research agendas, flexibility in accepting changes to project execution, and recognition of civil society organisations as well as citizens as applicants and grant holders.
- Fund positions and horizontal measures for community management.
- Treat increased transparency and public participation in research projects as an opportunity to reduce bureaucracy around such projects.

Infrastructure & Reward Systems

- Recognise and support the integration of CS and OS as or within research infrastructures. In some sectors, there is a need for specific research infrastructures for CS, such as the Atlas of Living Australia, which supports biodiversity data collection through CS projects. In other cases, CS can also be part of domain infrastructures, e.g. My Ocean Sampling Day, an environmental sampling project that hosts their data at a global ocean data center. Lastly, CS and OS can be understood as providing a socio-technical research infrastructure in their own right.
- Open up research infrastructures in general, including for citizen scientists, and provide new ones where they are missing.
- Improve mediation between institutions and individual participants, different sharing cultures, and different reward systems.
- Adapt evaluation, promotion and incentive structures for rewarding OS and CS activities.

Further Research & Critical Discussion

- Deepen research on modalities and consequences of openness and participation in each step of a research cycle and across different disciplines.
- Promote opportunities of exchange between researchers and practitioners in order to detect and address adverse effects, including extended secrecy and control, exploitation of participants and infringements on the freedom of research.
- Enrich the Commons in ways that benefit communities engaged in CS and OS projects to ensure that they can contribute to sustainable development goals and other societal challenges.
- Continue discussing empowerment specifically in the context of CS and OS approaches, whether by increasing awareness through public engagement or through deeper engagement and co-creation.

Case study 3: Project SOHA - Open Science in Haiti & Francophone Africa

http://projetsoha.org/

Project SOHA explores the obstacles preventing the adoption of open and collaborative science in universities in Haiti and Francophone Africa and provides tools to overcome them. This action research project starts from the premise that universities practicing open science can become powerful tools for local sustainable development.

CS aspect: The project recognised that open science - that is, science for and with the public - cannot simply be an academic question. It must also be open to participation, demands, criticism and knowledge of citizens, bringing them in closer contact with researchers to develop solutions that address their concerns.

OS aspect: The research action was based on open access, open science hardware, cognitive justice, commons, collaborative work, openness in African academia.

The project has identified eight forms of cognitive injustice that prevent graduate students and scholars from Francophone Africa and Haiti to transmit and produce knowledge in service to the sustainable development of their communities.[19]

Case study 4: Wikidata - Collaborative Public-Domain Knowledge Graph

https://wikidata.org/

Wikidata is the edit button for Linked Open Data – a multilingual collaborative database collecting structured data to provide support for Wikipedias and their sister wikis, and to anyone in the world, including various research communities across domains.

CS aspect: Data is entered and curated by Wikidata editors – about 20,000 people contribute per month, in their language. They manage content, tools and policies and integrate Wikidata with external resources like governmental, cultural or research databases.

OS aspect: Wikidata is based on open standards, and every change to content or software is immediately recorded in public. The data is published under CC0 – the Creative Commons Public Domain Dedication 1.0 – allowing for reuse without restrictions. Wikidata provides sustainable infrastructure (e.g. persistent identifiers, queriability) that is useful to research in general, including OS & CS. Openness and multilinguality broaden the contributor, user and funder communities.

Conclusion

Citizen Science and Open Science are complex concepts in the making. Both are insufficiently studied, and there are no easy ways to survey the landscape of either paradigm. While CS and OS can save resources, they also require them to be successful, along with major shifts in culture and society. They do not promise instant rewards, but offer instead substantial transformations of research and how it is rooted in our societies. Citizen Science and Open Science are both powerful on their own, but due to their manifest synergies, they can be even more effective when combined. While CS practices depend on opening up science and making other adjustments to the research system, OS needs to include citizens more profoundly in order to deliver on its promises. Further support for both OS and CS is required for an open and inclusive approach to RRI. More case studies can be found at *https://ecsa.citizen-science.net/.*

Recommendations

Based on the points discussed above, the following recommendations are made:

1. Open Science and Citizen Science will often benefit from each other and should be jointly considered in research and innovation. While not all research is susceptible or will benefit to the same degree, there will often be synergies of being open and reaching out.

2. CS and OS should be explored and developed further with attention to synergies between them. Ensure support for continuing and expanding upon existing community-driven initiatives around OS and CS. The international nature of both approaches to research should also be taken into account and cooperations fostered.

3. Targeted actions with dedicated support to CS and OS are still required, as both trends are still evolving. At the same time, public funding for research should broadly facilitate OS and CS to exploit its full potential. Therefore, existing systems (funding, rewards, impact assessment and evaluation) need to be assessed and adapted in order to become fit for CS and OS.

4. Education and training is essential for CS and OS to spread and develop further. In addition, more research, critical reflection and exchange between researchers and practitioners should be fostered.

Tools and infrastructures, in particular shared ones for OS and CS, have a potential for leverage and require dedicated support. This includes considering particular CS needs when constructing infrastructures in support of OS (and vice versa).

How to Cite

DITOs consortium, (2017). *Citizen Science and Open Science: Synergies and Future Areas of Work.* DITOs policy brief 3.

References

1. Fecher, B. & Friesike, S. (2014). Open Science: One Term, Five Schools of Thought. In: S. Bartling, S. Friesike, eds., Opening Science. The Evolving Guide on How the Internet is Changing Research, Collaboration and Scholarly Publishing, pp. 17-47. Available at: http://book.openingscience.org/
2. Wikipedia, (2017). Open Science. Available at: https://en.wikipedia.org/w/index.php?title=Open_science&oldid=805503923
3. Eitzel, M. et al. (2017). Citizen Science Terminology Matters: Exploring Key Terms. Citizen Science: Theory and Practice, [online] 2(1), p.1. http://doi.org/10.5334/cstp.96
4. European Citizen Science Association (2015). 10 Principles of Citizen Science. Available at: https://ecsa.citizen-science.net/documents
5. The Data Spectrum developed by the ODI speaks to this point: https://theodi.org/data-spectrum
6. OCSDNet (2017). Open and Collaborative Science Manifesto. Available at: https://ocsdnet.org/manifesto/open-science-manifesto/
7. Geoghan, H. et al. (2016). Understanding motivations for citizen science. Final report on behalf of UKEOF, University of Reading, Stockholm Environment Institute (University of York) and University of the West of England. Available at: http://www.ukeof.org.uk/resources/citizen-science-resources/MotivationsforCSREPORTFINALMay2016.pdf
8. Groom, Q. et al. (2016). Is citizen science an open science in the case of biodiversity observations?. Journal of Applied Ecology, [online] 54(2), p. 612-617. DOI: 10.1111/1365-2664.12767
9. Nold, C. (2016). Metrics of Unrest: Building Social and Technical Networks for Heathrow Noise. In: F. Callard, K. Staines, J. Wilkes, eds., The Restless Compendium: Interdisciplinary Investigations of Rest and Its Opposites. Cham: Palgrave Macmillan, pp. 149-156.
10. West, S. & Pateman, R. (2017). How could citizen science support the Sustainable Development Goals?. Discussion brief. Available at: https://www.sei-international.org/publications?pid=3255
11. Göbel, C. et al. (2017) European Stakeholder Round Table on Citizen and DIY Science and Responsible Research and Innovation. Doing-it-Together Science Report. URI: http://discovery.ucl.ac.uk/id/eprint/1563626
12. Vohland, K. & Göbel, C. (2017). Open Science und Citizen Science als symbiotische Beziehung?. TATuP Zeitschrift für Technikfolgenabschätzung in Theorie und Praxis, [online] 26(1-2), p. 18-24. https://doi.org/10.14512/tatup.26.1-2.18
13. Schade, S. et al. (2017). Scientific data from and for the citizen. First Monday, [online] July 2017. http://dx.doi.org/10.5210/fm.v22i8.7842
14. Gobel, C. et al. (2017). Stakeholder Analysis: International Citizen Science Stakeholder Analysis on Data Interoperability. Final Report. Washington, DC: Woodrow Wilson International Center for Scholars. Available at: https://www.wilsoncenter.org/publication/international-citizen-science-stakeholder-analysis
15. European Commission (2016). Open Innovation, Open Science, Open to the World – a vision for Europe. Directorate-General for Research and Innovation Directorate A – Policy Development and Coordination Unit A1 – Internal and external communication. Available at: http://www.openaccess.gr/sites/openaccess.gr/files/Openinnovation.pdf
16. Ceccaroni, L. & Lendak, I. (2017). Minutes of WG5 workshop in Novi Sad: "Towards a new ontology of Citizen Science". [workshop report]. Available at: https://www.cs-eu.net/sites/default/files/media/2017/05/COST-WG5-Ontologies-NoviSad-minutes-2017.pdf
17. Sturm, U. et al. (2017). Defining principles for mobile apps and platforms development in citizen science. Research Ideas and Outcomes 3: e21283. https://doi.org/10.3897/rio.3.e21283
18. Wilkinson, M. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3, [online]:160018. http://dx.doi.org/10.1038/sdata.2016.18
19. Piron, F., et al. (2016). Justice cognitive, libre accès et savoirs locaux. Pour une science ouverte juste au service du développement local durable. Éditions science et bien commun, accessible at: https://scienceetbiencommun.pressbooks.pub/justicecognitive1/

All web resources were accessed at the end of December 2017.

Colophon

This policy brief was facilitated by the lead authors ECSA & eutema through open interaction and discussion with the ECSA Citizen Science and Open Science working group. While this was carried out as part of H2020 'Doing It Together Science' (DITOs) Coordination and Support Action project, the views expressed in it do not reflect the consensus opinion of DITOs partners.

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