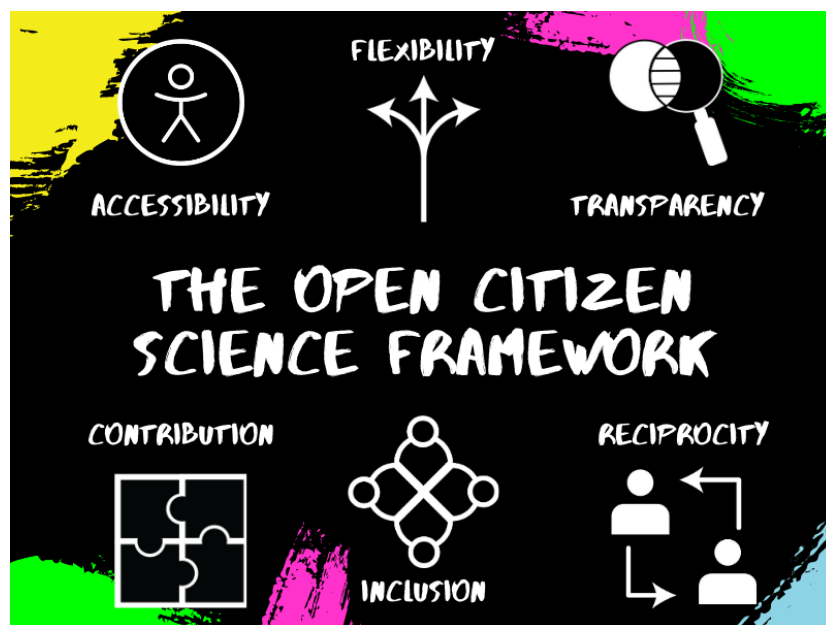


Breaking Traditional Scientific Boundaries with Open Citizen Science

Kymberley Scroggie, Yaela Golumbic and Alice Motion
SCOPE Group, The University of Sydney, NSW, Australia

Citizen science has grown in popularity over the past decade with a boom in the number of projects on offer. But is citizen science reaching its full potential?

In this article we present an integration of citizen science and open science, proposing a new framework - Open Citizen Science Framework. By integrating citizen science and open science, we believe that a new and more inclusive and equitable practice can be formed that concurrently address both the needs of science and society.



What is open science?

Open science is "transparent and accessible knowledge that is shared and developed through collaborative networks" (Vincente-Saez and Martinex-Fuentes, 2018).

Open science can accelerate innovation (Jeschke *et al.* 2019), increase societal understanding and expertise in science and how it influences governmental action (Levin *et al.* 2016) and transform the way in which scientific knowledge is generate and disseminated within and beyond the scientific community (references). Open science practices also improve research efficiency, expedite the rate of knowledge generation and ensure a greater level of research quality, integrity and reproducibility (Woelfle, Olliaro, and Todd 2011; Munafò *et al.* 2017).

The products of open science have had tangible impacts on society. Take for example, the development of the widely used operating systems Linux and Android, crowdsourced information (e.g. [Wikipedia](#) and [Open Street Map](#)) and research projects such as [Open Source Malaria](#) and the [Allen Institute for Brain Science](#).

Open science practices

The practices of open science generally fall within a least one of Fecher and Friesike's (2014) *five schools of thought: public, measurement, democratic, pragmatic and infrastructure*. Below we have translated these schools of thought into open science practices that align with or support their derivative assumptions and goals.

OPEN SCIENCE			
School of thought	Assumption	Goal	Practices
Public	Science needs to be made accessible to the public	Making science accessible for and to all citizens	Citizen science Science communication
Measurement	Scientific contributions need alternative impact measurements	Developing an alternative metric system for scientific impact	Peer review processes Altmetrics
Democratic	The access to knowledge is unequally distributed	Making knowledge freely available to everyone	Open access publishing Preprints Pre-registration Registered reports
Pragmatic	Knowledge creation could be more efficient if scientist worked together	Making the process of knowledge creation more efficient and goal oriented	Open data, code, research materials and methods Documenting evidence assessment and data analysis
Infrastructure	Efficient research depends on the available tools and applications	Creating openly available platforms, tools and services for scientist	Open source research tools, platforms and software Open collaboration

The Open Citizen Science Framework

The Open Citizen Science Framework is built on three pillars: accessibility, flexibility and transparency and builds upon the three dimensions of citizen science: contribution, inclusion and reciprocity developed by Golumbic et al. (2017).

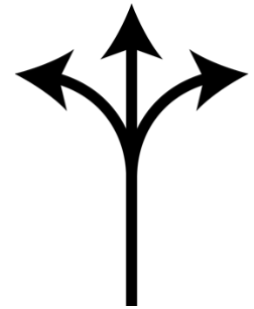
Accessibility



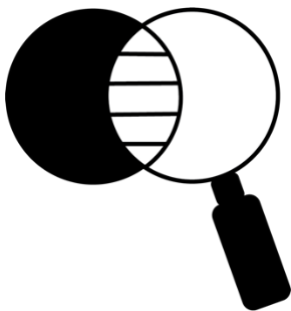
The open access principal of open science primarily involves making literature freely available to everyone. Access to information alone, however, does not ensure that it is accessible. Accessibility also relates to the structure, format and comprehensibility of the information that is being shared. A new and intensive mission for many, adherence to science communication best practices is a key element in creating accessible projects. In the context of the OCSF, accessibility doesn't only information but also to the reach of projects and infrastructure that enables diverse participation.

Flexibility

Key to successful open collaboration is flexibility. Flexibility can open the door to bottom-up design approaches and implementation of novel ideas. In conjunction with the consideration of new ideas arising from project participants, having flexibility can allow for new discoveries that may not have been previously hypothesized. A flexible citizen science project may include a greater range of activities, new approaches to data management, quality control and information sharing and/or a dynamic project management system for citizen scientists to engage with. Appealing to their diverse goals, abilities and interest this could conceivably increase public engagement in projects.



Transparency



Open science advocates for transparency in the project goals and values, scientific design and methodology, analysis, data and findings. It demands a thoughtful design of the scientific study, a process which in turn improves internal integrity and reproducibility. Through transparency, citizen science as a field can push for a more robust scientific practice which is deliberate and responsive to social needs. Introducing procedures that enable the public to see the research and decision-making process of scientists can help to restore public trust and show that science is a human-driven and collective endeavour that comprises stories of not only success but also failure and uncertainty.

On the utility of the OCSF

We acknowledge that the implementation of this framework may not be the easiest of tasks. It requires a paradigm shift and the investment of additional time and resources which go beyond traditional scientific practices and are not yet quantifiably measured or recognized by the academy. We also recognise the inherent tensions between and within some of the ideas we propose and explore – for example, programs may be forced to make trade-offs between data quality, privacy protection, resource security, transparency, and trust (Anhalt-Depies et al. 2019). There are, however, many ways to implement the pillars of the Open Citizen Science Framework into a citizen science project and the framework is not designed to be restrictive. Our intention is for projects to adopt aspects of the pillars that resonate with their scope and purpose to generate more inclusive and accessible citizen science research projects.

Question for discussion

How might you incorporate one of the OCSF pillars into your citizen science project?

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