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Opensciency - A core open science curriculum by and for the research community.

Opensciency is core open science curriculum material, drafted to introduce those beginning their open science journey to important definitions, tools, and resources; and provide for participants at all levels recommended practices. The material is made available under a CC-BY 4.0 International license and is structured into five modules:

- Ethos of Open Science
- Open Tools and Resources
- Open Data
- Open Software
- Open Results

Citation

All versions can be found and referenced to this DOI: 10.5281/zenodo.7392118.

To credit and cite the material, use the following citation - where possible, please include all authors name as listed in the CITATION file:

> OpenSciency Contributors (2023, February 22). Opensciency - A core open science curriculum by and for the research community. Zenodo. https://doi.org/10.5281/zenodo.7392118

Details

Opensciency is a result of the work of more than 40 open science experts and practitioners from across the world and from different disciplines. The first draft of the curriculum material was developed from June 27 - July 1, 2022 as part of the Transform to Open Science (TOPS) Open-Core sprint. More information about the NASA TOPS initiative is available via their website. After the TOPS Community Panel on October 6, 2022, the original contributors created the Opensciency repository to allow all contributors to further engage with the curriculum and invite review on the initial draft material from the wider research community.

We encourage the wider community to reuse the material, and we are especially interested in creative approaches to displaying the material. An example we like is Elements of AI.

Let us know if you have a creative approach to displaying and reusing the material by submitting an issue. Please provide your contact details so we can add you to the contributors list.

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Ethos of Open Science

What is Open Science and what practices does it promote?

Introduction

This is the first lesson in the module on the Ethos of Open Science. We'll start explaining what we mean by the word, "ethos". Ethos is defined by Merriam-Webster as "the distinguishing character, sentiment, moral nature, or guiding beliefs of a person, group, or institution". So this lesson is about what makes Open Science, as an approach to knowledge-production, unique or distinguishable from other scientific methods.

Note that "ethos" is not exactly "ethics", but it is a broad enough term to include the moral attitudes held by the individuals or institutions practicing open science. To make it clear that there is a moral element to this discussion, we speak of "responsible Open Science" going forward.

The lesson introduces the concept of open science as a whole, by explaining the history underpinning open science, what open science is, and how it works. It then discusses different components of open science and the pillars that make them up. At the end of the lesson, students will have an understanding of the brief history of open science and its definition.

Open science goes beyond publishing– it is a redefinition of scientific collaboration and output. It is a culture intended to promote science and its social impact. Open science creates new opportunities for different stakeholders including researchers, decision makers, and public participants. Open science increases study transparency, repeatability, reproducibility, and confirmation. We expand what these terms mean and why they matter throughout this module and later OpenCore modules.

Context and Definition

Science evolves through collaborative development of theories and practices that are open for others to learn and build on. Throughout the ages - whilst in some cases, education and science was out of reach for the general populace and may have been kept for a privileged few, there have been other educational and scientific resources that were purposefully made available for others to re-use. Think of how dictionaries and encyclopedias have been around for centuries specifically to share standards of knowledge. (The first "dictionary" dates back over 3,000 years!) Libraries, in turn, have existed for millennia to serve as repositories of knowledge in diverse formats, from ancient tablets and scrolls, to the books we expect to see today. Public museums have also been around for some time and play the role of educating people, as well as maintaining archives for researchers to gain further insights from.

Institutions and practices throughout the ages have facilitated humanity's endless desire for knowledge. As far back as the Medieval era, we already find physicians being encouraged to

review one another's work to ensure it was carried out appropriately (Rogers, 2021). Today, we call this practice "peer review". And, during the Enlightenment, scientists formed networks with whom they shared their theories via hand-written letters, and the adoption of the printer allowed for the emergence of scientific institutes and journals (Green, 2017; see Kherroubi Garcia et al., 2022).

However, open science has only become a distinct set of practices in recent decades. We can see open science as both being encouraged by social and technological developments, and responding to problems in the scientific process. The emergence of the internet and other digital technologies have more recently allowed for science to be conducted even more collaboratively. In 1971, Project Gutenberg started making books in the public domain available online. In 1987, we saw the first open access journal being published. In 1991 the central storage platform arXiv was launched for the exchange of manuscripts in physics (though without peer review) (Ginsparg, 2021).

However, these endeavors do not amount to open science in the sense we discuss it today. In recent years, we have learned of various issues in the scientific process that necessitate specific responses. Two such issues are the replication crisis (Fidler & Gordon, 2013; Elsherif et al., 2021a) and publication bias (Joober, et al., 2012; Elsherif et al., 2021b). The replication crisis refers to scientific findings not being validated by other scientists' efforts to replicate them. The publication bias amounts to the greater ease to publish scientific findings that only "very clearly" confirm or disprove hypotheses.

Thus, open science captures both the spirit of making knowledge more accessible *and* responding to poor scientific practices. We will discuss more reasons why open science is important, both the personal benefits and as a public good, in Lesson 2 of this module, "Benefits and Challenges of responsible Open Science: Why does it matter?"

Definitions of Open Science and responsible Open Science

Formal definitions and governance mechanisms to ensure best practices in open science have emerged alongside the open science movement.

- In 1997, COPE was established and has since supported the fostering of responsible publishing culture.
- The 2001 Budapest Open Access Initiative provided a clear working definition of *open access*, one of the components of open science (as we will see shortly).
- In 2012, the Contributor Role Taxonomy was developed so that more diverse collaborators in research can be adequately credited for their work.
- The 2013 Declaration on Research Assessment then outlined best practices in the assessment of research.
- In 2014, the Open and Collaborative Science in Development Network was established to enable open science approaches to developmental research for the Global South.

- 2014 also saw the launch of the Data Citation Principles, which advocate for – amongst other things – making data independently citable.
- The 2016 FAIR principles emerged as a way to guide practices in open science, and enabled the implementation of the Data Citation Principles.
- The 2018 CARE principles established data governance practices for indigenous data and practices.

In this complex context, we can draw on a few definitions of *Open Science*:

"Open Science is transparent and accessible knowledge that is shared and developed through collaborative networks" (Vicente-Saez & Martinez-Fuentes, 2018).

"Open science is [...] an inclusive construct that combines various movements and practices aiming to make multilingual scientific knowledge openly available, accessible and reusable for everyone, to increase scientific collaborations and sharing of information for the benefits of science and society, and to open the processes of scientific knowledge creation, evaluation and communication to societal actors beyond the traditional scientific community. It comprises all scientific disciplines and aspects of scholarly practices, including basic and applied sciences, natural and social sciences and the humanities, and it builds on the following key pillars: open scientific knowledge, open science infrastructures, science communication, open engagement of societal actors and open dialogue with other knowledge systems (UNESCO, 2021).

Globally, Open Science is being valued and given importance as it recognizes disparities and regional differences, providing a framework to handle challenges and contribute to minimize knowledge, technological and digital differences between countries. For instance, when different researchers from across the globe are invited to research collaboratively, trust and novelty increases and as a result it improves quality, efficacy and responsiveness in research as being the benefits of Open Science.

Here are some other definitions of Open Science. Are there any more you would add?

Open Science is a practice for increasing the accessibility and transparency of scientific research. The concept of Open Science is built around shared principles such as inclusion, fairness, equity, & sharing (Zee & Reich, 2018).

An umbrella term reflecting the idea that scientific knowledge of all kinds, where appropriate, should be openly accessible, transparent, rigorous, reproducible, replicable, accumulative, and inclusive, all which are considered fundamental features of the scientific endeavor. Open science consists of principles and behaviors that promote transparent, credible, reproducible, and accessible science. Open science has six major aspects: open data, open methodology, open source, open access, open peer review, and open educational resources. (FORRT open science glossary, https://forrt.org/glossary/open-science/)