

Open Science for Sustainable Research Careers

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Introduction

What is Open Science?

Open Science (OS) is a central concept to the advancement of science in Europe through the 21st century. Multiple definitions exist and are in a constant flux, alongside the continuous changes on the conceptual and contextual level that are induced by a more “open” and “opening” science mindset. The UNESCO (2021), defines open science as:

“[...] open science is defined as 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.”

At its heart, open science continuous the thought that all scientific work is standing on the shoulders of giants but for that the foothold has to be visible, accessible and reproducible in such a way that it leads to a stable composition and a common understanding about the principles that need to be known and mastered to be part of an “opened” science which provides the shoulders for upcoming generations.

As articulated in the European Commission’s ‘A Vision for Europe’, Open Science (OS) and its underlying principles will form the backbone of research and other academic activities in the not too distant future. To advance towards this vision, the European Commission and 14 European national research funding bodies recently released Plan S, making a major step towards deploying principles of Open Science (OS). This step made it clear that indeed OS became a central concept to the advancement of science and Higher Education (HE) in Europe and therefore is vital to be mastered by the researchers that make up higher education but also all areas and organisations in which research is conducted.

The Need for Open Science Training for a Sustainable Researcher Education

To promote a more transparent scientific agenda, scientists need to attain interdisciplinary and transversal skills beyond their specialisation. Researchers need to be experts in research management, aware of the diversity of intercultural research groups and disciplines, and manage stressful steps in their research. Importantly, researchers also need to be able to engage broader audiences, being confident, capable communicators.



OS skills are critical to academia and the corporate sector in the 21st century. Researchers need to be confident, capable communicators, experts in research management, aware of the diversity of intercultural research groups and disciplines, manage stressful steps, but remain open and innovative at the same time and integrate fundamental IT skills to support the analytical parts of their work.

The OEduverse project and training programme aims to establish a personalised training framework, to provide the foundations of OS skills training to early stage and experienced researchers, which reflects labour market needs. But open science is not only becoming a vital skill for researchers on the global job market, it also supports an inherent understanding of best practices and structured approaches for research. To truly support open science, it is needed to decompose all steps of science into their composing elements and evaluate and design how the single element can be opened. So in that sense, learning about open science yields also the valuable potential to learn about a structured, elemental and thoughtful process of conducting research, that is open science.

Being aware of the composing elements and mastering their use, enables researchers of all career steps to be more in control of the how and what of their research and as such gain the agency to take control about a vital part of their career, story and environment.

Goals of the Training

The open science training parts of the OEduverse framework do split into three different considerations. Foremost the training aims to lay the foundation of understanding and utilising open science by learning about the fundamental concepts, its vision and each of the different building blocks. Content-wise the core is following a work breakdown structure to split the overall research and open science workflow into connected or singular elements.

By gaining an understanding of the building blocks, the training uses the learned concepts to contextualise in a second consideration the daily research with its representing open science counterparts. Following the analogy that the small being mirrored in the whole, the composing parts of the open science process do represent in multiple ways the steps of a long term research career, following mirroring stages, such as setting up your research/planning first career steps, storing and managing data/sustaining your research story, organising your writing/writing the narrative of your career and more. Also an understanding is gained in which stages of a career the composing steps and methods of open science can be relevant.

Finally considerations and as such goals are discussed in the frame of data management for open science. Data in more than one way is a crosscutting component and resource. It has to be managed to enable higher concepts of open science such as reproducibility, ease of sharing and stacking of interconnected results and with that the further development of research and science as a whole.

But it is not only about management. The idea of reproducibility, encapsulates that data has to be handled and organised with care to serve and enable more than one iteration of use. Beyond the technical perspective, reproducibility is also about the ability to build an argument which is sound, goal oriented, scientifically anchored and as such compelling as a



- sequential or interconnected - story about experimenting, researching and revelations. But it also packs a language and narrative of serving the scientific community but also the wider public, opening the steps of scientific endeavours as an open narrative for change and achievement.

Enabling the Hack(athon): How Open Science Helps Designing the Personal Research Environment.

Two major aspects of designing the personal research environment are an understanding and overview over the building blocks of what science is, as well as mastering a set of skills to operate and therefore control the individual research - structure-wise, content-wise, method-wise. In the personal research environment, multiple factors can impact the sense of safety, support and overall mental health and with that productivity or personal perspective.

Having or regaining control over the personal environment and particularly the personal research environment can be a major factor for improvement and stabilisation, yet it is a challenging task. Open science and its focus on separability of tasks, yields a sense of control and management. Equally it helps to find a common language to compose, de-compose and communicate scientific work, offering vocabulary and structure that is then an important input for the designing of a better, personal research environment during and especially at the end of the training programme.

Meeting points and Synergies with other Training

Understanding and mastering open science enables students to apply structured thinking onto their individual situation. The discovery of procedures that are comparable between domains or domain-agnostic, creates a sense of unity among participants. Entering mental health training, the structured thinking that is retroactively applied onto the personal work, creates an imminent readiness to not only enter a research reflection but a self reflection. Furthermore the sense of connectedness of research work can foster the understanding of the personal work and the personal environment being always connected to other persons that are in or intersect with that, which in turn can then be addressed in the mental health sessions.

Science communication and science is always connected to storytelling. Storytelling is an immersive task and endeavour, yet every story is built on the back of a structure, a flow and process that connect events, along the fabric of their emergence into an environment of sequence. Open science supports the ability to phrase stories by an understanding of story elements and sequence and connection. It splits research into meaningful elements and that sense of meaning carries over or translates into the narrative of the personal research.



Open Science Day

The OEduverse project designed and tested training on practical open science skills, and techniques that can be used across all disciplines. Participants of the open science day, will walk away with their own open science toolbox, a set of tools (both technological and best practices) that are used to conduct high quality research. Participants will also learn and understand the role of their research and their career in the wider context of society as well as what the recent and upcoming trends are in academic careers. The open science day is organised, designed and created by TIB, the University of Siegen and SciLink.

The Training Day Concept

Preparation

A week before the training participants are given a number of preparatory materials. These need to be consulted before the start of the training as a base introduction and a starting point of discussion.

The materials:

- SPOTIFY Playlist on Reproducibility (4.5hrs)
<https://open.spotify.com/playlist/4HifTLMCrPtQLOiTteAimR?si=cab88112939548d3>
- Pownall et al., 2020 (preprint). 'Navigating Open Science as Early Career Feminist Researchers'. PsyArXiv, 13 October 2020. <https://doi.org/10.31234/osf.io/f9m47>.
- Drummond, Dr Chris. 'Reproducible Research: A Dissenting Opinion'. Other, 21 September 2012. <http://cogprints.org/8675/>.

Participants can also access the eDoer platform (<http://edoer.eu/>) in preparation, which is an AI driven, open learning platform, to consult openly available learning content in a number of areas of Open Science. The TIB team is responsible for the technical support of this platform. The content in the platform has been co-curated and managed by TIB.

The following courses were made available for participants to be visited in preparation or alongside the training week:

- Python programming: <https://labs.tib.eu/edoer/en/dashboard/skills/1>
- R programming: <https://labs.tib.eu/edoer/en/dashboard/skills/2>
- Statistics with R: <https://labs.tib.eu/edoer/en/dashboard/skills/4>
- Statistics with Python: <https://labs.tib.eu/edoer/en/dashboard/skills/3>
- Approaches to scientific communication:
<https://labs.tib.eu/edoer/en/dashboard/skills/520>
- Zotero reference manager: <https://labs.tib.eu/edoer/en/dashboard/skills/488>



All courses are available free of charge for everyone. The eDoer platform is maintained by TIB and will remain available beyond the lifetime of the eDoer project.

Open Science Day Set-up

The Open Science Day is built up by six, each between 45 minutes and an hour long online sessions. These sessions are the following:

- Introductions and Using Open Science in your Career
- Debating Reproducibility
- Managing Research Outputs
- Data Management Philosophy & Approaches
- Visual Data Management
- Constructing a Profile for Impact

These six sessions follow the logic of three training modules, as outlined in the OEduverse Training Framework:

1. Using Open Science in your Career (Module 2.1)

This module aims at understanding the basic principles of open science by generating a high level view on OS related topics. Participants are put into discussions on OS tools and strategies for an open and personal research environment. Priority is given to hands-on exercises, debate, discussion, minimal “death by slides”. The module starts with an opening lecture from Madeleine Pownall (Pownall et. al, 2020), which is followed by a debate on the role of Open Science in scientific careers.

2. Open Science and Reproducibility (Module 2.2)

This module aims at understanding the driving principles of reproducibility and research evaluation by identifying and applying metrics relevant for reproducible research. In this module participants also reflect on traditional research evaluation in the light of open science principles. A flipped classroom method is used for participants to prepare and present their viewpoints. Participants engage in team debates to consider different sides of issues or reproducibility and evaluation and make their own informed minds on the right level of effort they need to invest in their own research.

3. Open Science and Data Management (Module 2.3)

This module aims at being proficient to use a number of OS tools to manage research data, software and publications open communication tools. This module is a hands-on, practical session for creating individual OS environments. Based on lessons learned in other modules, participants construct their own visual Digital Outputs Management Plan, deploying



FAIR & Open Science practices and e-infrastructure that suit their personal workflow and disciplinary specificities.

Open Science Day Schedule

The Open Science Day is supposed to be on Day 2 during the hackathon, but it can be also provided as a standalone one day long training. The day leads participants through the above mentioned six sessions. These sessions are divided by 15 minute long breaks, and in the middle of the day a 1 hour long lunch break is provided. This is essential to avoid the so-called zoom-fatigue, which is a term describing that participants find it hard to concentrate during long on-line video- conferencing sessions.

The day has three important facilitator roles:

1. Experienced OS expert as moderator and trainer (Ivo Grigorov, DTU)
2. Experienced researcher viewpoint (Gábor Kismihók, TIB)
3. Guest lecture of an early career investigator using OS (Madeleine Pownall, University of Leeds). This person doesn't need to be present all day, only during the relevant session (introduction).

The video conference platform is jointly managed by facilitator roles 1 and 2.

The outline of the day - with timing - is the following:

Module I: Open Science

Facilitators and Guest Speakers

Ivo Grigorov, DTU,
Gábor Kismihók, TIB
Madeleine Pownall, University of Leeds

Preparation

To prepare for the Open Science exercises, please find attached some background listening and reading. We do not expect you to go through all of it, but do try. The podcast includes segments 15-30 min which you can easily go through while exercising. The two articles should not take you more than an hour to absorb. We will work in teams on the day and cover each other's blindspots.

- SPOTIFY Playlist on Reproducibility (4.5hrs)
<https://open.spotify.com/playlist/4HifTLMCrPtQLOiTteAimR?si=cab88112939548d3>
- Pownall et al., 2020 (preprint). 'Navigating Open Science as Early Career Feminist Researchers'. PsyArXiv, 13 October 2020. <https://doi.org/10.31234/osf.io/f9m47>.



- Drummond, Dr Chris. 'Reproducible Research: A Dissenting Opinion'. Other, 21 September 2012. <http://cogprints.org/8675/>.

9:00 - 9:45

Introductions and Using Open Science in your Career

After a lecture from Madeleine Pownall (Pownall et. al, 2020) we will debate the role of Open Science in scientific careers.

9:45 - 10:00

BREAK

10:00 - 10:45

Debate on Reproducibility

Is there a reproducibility crisis? Is science broken? And why waste time on it, if it means we would spend less time on publishing? Participants will engage in team debate to consider both sides of the issue and make their own informed minds on the right level of effort they need to invest in their own research.

10:45 - 11:00

BREAK

11:00 - 12:00

Research Outputs

The research publication: the ultimate output? Or just the tip of the iceberg? The exercise will demonstrate the full range of outputs that come out of research, but which we fail to capture the impact of systematically, by applying FAIR Principles and Open Science practices.

12:00 - 13:00

LUNCH 🍽️

13:00 - 13:45

Data Management Philosophy & Approach

How do you turn a bureaucratic ask by funders into a sharp tool for reproducibility AND winning grants? You upgrade your data management from a focus on "data" to a focus on "outputs", and embed it into your research method. Participants will be exposed to real project examples, from proposal formulation to proposal evaluation impact.



13:45 - 14:00

BREAK

14:00 - 14:45

Visual Data Management

Based on the entire day's lessons learned, participants will construct their own visual Digital Outputs Management Plan, deploying all FAIR & Open Science practices and e-infrastructure that suit their personal workflow and disciplinary specificities.

14:45 - 15:00

BREAK

15:00 - 15:45

Constructing a Profile for Impact

During the last session of the day, you will come together to learn how to construct your professional profile to reach maximum impact, which is especially important for the early stages of your career. You will also debrief one another in a group discussion

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Closing Remarks & Incorporating the lessons learned into the final day presentation

15:45 - 17:00

Closing

Closing remarks and incorporating the lessons learned into the final day presentation



Day Schedule Breakdown

Now in the following, for each session a short description is given about how the sessions are conducted and what needs to be considered in selected scenarios. What tools were used and for what purpose? What are the take-aways from that session?

Session 1 - Introductions and Using Open Science in your Career

The first session starts with a lead presentation that should give a glimpse into open science and provide vision and motivation for an early stage reflection. After a lecture from Madeleine Pownall (Pownall et. al, 2020) we will debate the role of Open Science in scientific careers.



Figure1: Providing vision: the European sustainability goals do motivate us to think of sustainable science which is in need of open science thinking to reach that goal.

Session 2 - Debate on Reproducibility


Is there a reproducibility crisis? Is science broken? And why waste time on it, if it means we would spend less time on publishing? Participants will engage in team debate to consider both sides of the issue and make their own informed minds on the right level of effort they need to invest in their own research.



Figure 2: Not being able to reproduce studies is a major inhibitor of scientific development. However, if reproduced we can gain the chance to uncover shortcomings and limit the impact of flawed works.

Session 3 - Research Outputs

The research publication: the ultimate output? Or just the tip of the iceberg? The exercise will demonstrate the full range of outputs that come out of research, but which we fail to capture the impact of systematically, by applying FAIR Principles and Open Science practices.



EXERCISE: List Research Outputs (*some* Answers)

1. Dataset	14. Research Infrastructure
2. Database	15. Patents
3. Methodology (including model)	16. Commercial Systems
4. Protocol	17. Taxonomies & Ontologies
5. <u>ISO Standard</u>	18. Training/e-learning tools/services
6. Toolkit	19. Videos (professionally prepared, polished products, not amateur recordings!)
7. Software (other than model)	20. Policy report
8. Research/virtual environment	21. Decision-Support Tools / Frameworks
9. Negative results	22. <u>White papers</u>
10. Blueprints, Protected Design	23. Research Strategy / Roadmap
11. Demo, Proof of Concept	24. Reviews / Expert Evaluations
12. Prototypes (including appliances, drones, sensors etc.)	
13. Knowledge Services (advice)	

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Figure 3: We think of research outputs as publications. However, with a conscious effort and the help of the components of open science, the list of outputs critically expands.

Session 4 - Data Management Philosophy & Approach


How do you turn a bureaucratic query by funders into a sharp tool for reproducibility AND winning grants? You upgrade your data management from a focus on “data” to a focus on “outputs”, and embed it into your research method. Participants will be exposed to real project examples, from proposal formulation to proposal evaluation impact.

F.A.I.R. data principles


F
indable




A
ccessible



I
nteroperable




R
eusable



- Drafted in a workshop in 2014
- [Nature article](#)* and support by [FORCE11](#)
- Received international recognition
- Technology agnostic
- Discipline independent
- Both the data and the metadata
- Human readable and machine readable

* Wilkinson, M. D. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci. Data 3:160018 doi: 10.1038/sdata.2016.18 (2016).



australian research data commons
Built from [ands](#) [nectar](#) [RDS](#)

[Image by Sanja Pundir CC-BY-SA](#)

Figure 4: Data management is a vital task in data driven tasks and projects. With the FAIR principles the management becomes the enabler for reproducibility.

Session 5 - Visual Data Management

Based on the entire day's lessons learned, participants will construct their own visual Digital Outputs Management Plan, deploying all FAIR & Open Science practices and e-infrastructure that suit their personal workflow and disciplinary specificities.

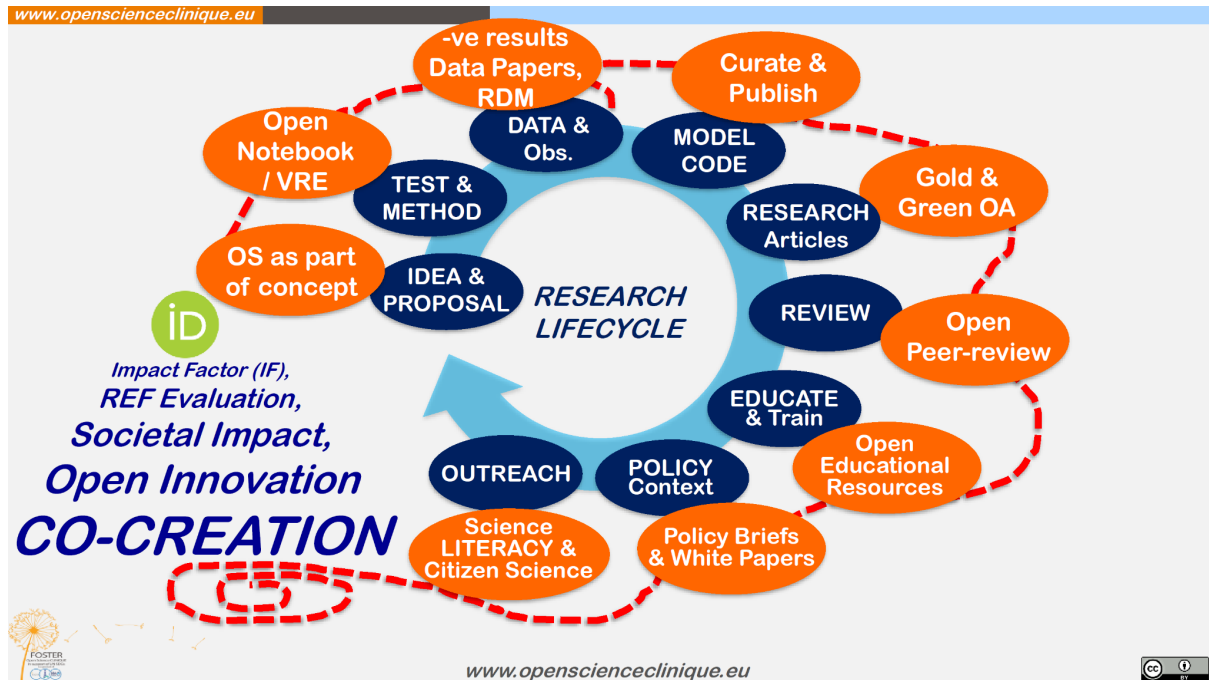


Figure 5: The profound overview over the aspects of open publishing, create a visual guide to open data and open publishing.

Session 6 - Constructing a Profile for Impact and Closing

During the last session of the day, you will come together to learn how to construct your professional profile to reach maximum impact, which is especially important for the early stages of your career. You will also debrief one another in a group discussion

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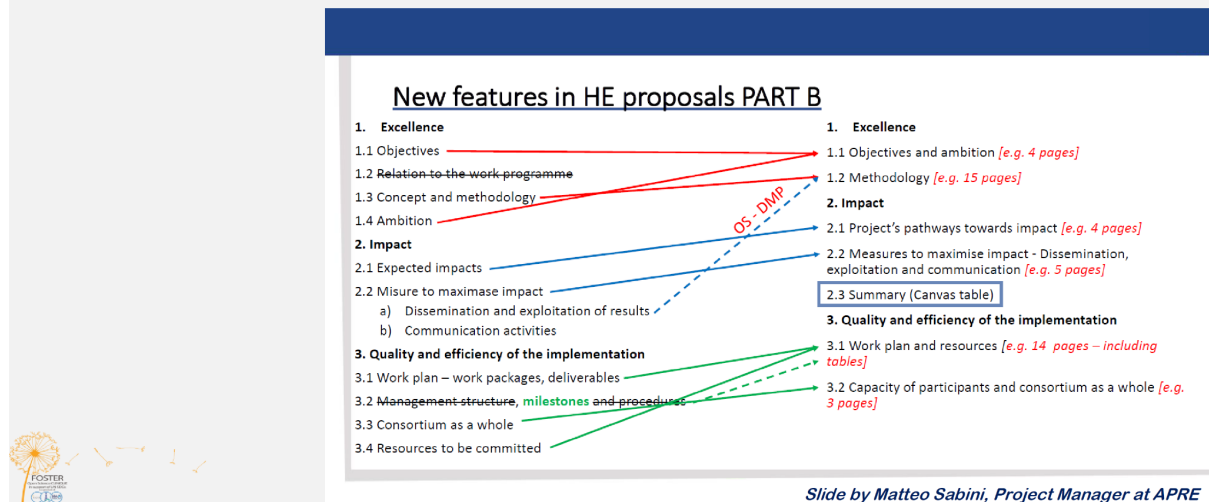


Figure 6: More than one item can be mapped between ERC grant proposals and open science steps (and benefits).

Closing (optional)

Closing remarks and incorporating the lessons learned into the final day presentation (if the Open Science Day is part of the one week long programme).

Open Science Module Outputs and Integration

Based on participant's feedback and the final presentation the open science day was treated as a foundational element of a research environment. This element is responsible for the organisation of fundamental research related tasks, like data management, planning, carrying out and disseminating research studies, networking with peers, etc. Participants valued the possibilities open science tools and practices provided them, when it comes to their professional visibility and career opportunities in and outside of academia. Furthermore open science infrastructure seemed a vital ground for a healthy academic workplaces, which is a point taken up and brought forward by the Mental Health Day. When it comes to dissemination and communication the awareness of open access communication opened a door towards effective and well targeted communication mechanisms, which were discussed during the Communication Day.

More specifically, the main takeaways of participants were:

- Awareness and impact of open science practices on individual career development and individual visibilities as experts
- Awareness and impact of open science practices on research funding and research planning
- Effective and transparent research data management with an extensive toolkit of openly available data management tools and practices
- Effective dissemination of research results with an extensive toolkit of open access publication tools and practices



Events and Lessons Learned

In general the open science training day was received well and it has been an integral part of the whole week. Its position on the second training day has been well confirmed, just as its fundamental role in academic working environments. It is noteworthy to mention, that the day itself can be utilised as a stand alone training. Nevertheless a single day of training doesn't really allow participants to dive very deep in the topics, which were covered during the training. Participants indicated that more information about specific open science tools and technologies would be a plus to this course. To overcome this hurdle, the eDoer system has been utilised, in which openly available training content has been curated on a number of tools.

The mode of instruction was also received well. The moderator together with an experienced researcher created a very discussion and debate driven reflective course environment, which was appreciated by almost all participants.



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Pownall et al. (2020) (preprint). Navigating Open Science as Early Career Feminist Researchers. PsyArXiv, 13 October 2020. <https://doi.org/10.31234/osf.io/f9m47>

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