Open Science: Principles and Practices

COURSE SYLLABUS TEMPLATE - Version 1 (April 11 2023)

PREFACE

This syllabus and collection of resources are intended to be used and reused to **implement Open Science into formal education** such as an accredited course at a higher education institution (HEI). The creators of the syllabus encourage educators to use these materials to prepare for the course accreditation process.

The **target audience** of the course are ***early career researchers starting from the upper division undergraduate level up through postdoctoral researchers***. Additionally, the course may be suitable for professionals working as ***research software engineers, technicians, and other types of scientific staff***.

The **planned length of the proposed course** is ***12 weeks with two 90 minute lectures per week***. This can be lengthened or shortened depending on the course and teaching requirements of specific HEIs. The course is designed with a **capacity** of around ***20 students*** in mind.

Since frequency & types of assignments and grading policies differ vastly between different international HEIs, *we do not propose a grading or evaluation scheme* with this syllabus. We do propose **example assignments with basic instructions** so that course instructors can select the most appropriate exercises that suit their local needs.

This course was designed by the Open Science Education Working Group at the Open Science Retreat 2023**.** The core group members and creators of this syllabus include:

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COURSE DESCRIPTION

Open Science is a movement that seeks to make scientific research more transparent, accessible, and reproducible. This course will cover the key principles and practices of Open Science, including open access publishing, data sharing, preregistration, and replication. We will also discuss the benefits and challenges of adopting Open Science practices and the implications of Open Science for the research community.

COURSE OBJECTIVES

The main objectives of this course are to introduce participants to the pillars of Open Science and provide them with first practical steps to start implementing Open Science in their research. Participants learn how to develop a roadmap for their projects and work environments. Since Open Science is all about cultural change in science we will discuss the change management aspects as well as policy considerations.

Learning Objectives

After taking this course, students will

know the core pillars, motivations and values of Open Science.

understand the basics of open methodology and tools and practices used in working openly and transparently.

gain competence in Open Data concepts such as FAIR principles, legal & ethical considerations with open data, and methodology for sharing data.

gain competence about Open Source tools and practices.

understand the fundamentals of Open Access publishing and Open Peer Review.

be able to perform constructive peer review.

have an overview of how to engage with different stakeholders in all parts of the research process.

understand the process and tools of culture change.

be able to identify problem areas in their own work environment, suggest actions for improvement, and create a culture change management roadmap.

COURSE FORMAT

The course will be based on a blended-learning format. Each class will consist of two phases: in a self-study phase (to be completed before each class), students will review course material (see resources in table below). In-class instruction will combine lectures with interactive components. Based on the background and goals of the students, field specific information (e.g. electronic lab notebooks for laboratory sciences) can be included.

COURSE CONTENT

Course Schedule

12 weeks with 2 lectures (90 minutes) per week

Week	Lecture	Topic	Resources	Assignments
1	1	**Introduction / Overview** ● Pillars ● Policies ● Movements ● Values/Communities	P.1-100 Open Science Training Handbook	Understanding open science - A Case Study Optional assignment - The Dilema Game
1	2	**Open Methodology** ● Why open methodology? ○ Why is this important? ● Record Keeping: Data Management Plans and documentation. ○ Why is it important to keep track of your data and resources, and tools available.	The case for formal methodology in scientific reform | Royal Society Open Science (royalsocietypublishing.org) Easing Into Open Science: A Guide for Graduate Students and Their Advisors | Collabra: Psychology | University of California Press (ucpress.edu) MSE - Research Data Management (kit.edu) Ten simple rules for creating DMPs	Data management and Documentation
2	3	**Open Methodology** ● Workflows: Tools used to manage research data ○ Clear documentation, tools used, software employed. How to share and display clear content of your research.	What is an Open Workflow? | Program for Open Scholarship and Education (ubc.ca) Best Practices for Organizing Work | Program for Open Scholarship and Education (ubc.ca) Developing_a_research_workflow_and_back-up_plan_for_your_work.pdf (udel.edu)	Assignment - Reflection on workflows in your research methods
2	4	**Open Methodology** ● Preregistration: ○ Why is this important? Improving transparency and validity of your findings. ○ How to preregister your study and where. ● Publishing Research protocols: ○ Providing a record of your plan of action, methods and analysis to allow for greater	Frontiers | How to Crack Preregistration: Toward Transparent and Open Science (frontiersin.org) Preregistration (cos.io) Methods (how-to-open.science) Open Protocols - Open Science Knowledge Base (how-to-open.science) Open Science Tool to Publish	Designing a preregistration template

		transparency in yor research.	Protocols | Lane Library Blog (stanford.edu) Isolation of nuclei from frozen tissue for ATAC-seq and other epigenomic assays (protocols.io)	
3	5	**Open Methodology** ● Data Exit Checklists ○ How to ensure that your data remains clear, understandable and secure during transition periods. ● Open Hardware: ○ Why accessible hardware is important in open science research	Use a data exit checklist before you leave! | Research Data Management Service Group (cornell.edu) 'Open-hardware' pioneers push for low-cost lab kit | Nature Understanding Open Hardware and Citizen Science | OCSDNET	Defining exit strategies for your research
3	6	**Open Data** ● Definition of research data ● Levels of (data) openness ● The "why?" of open data	Introduction to (open) research data Overview on Open Research Data and Materials	Personal definition of research data
4	7	**Open Data** ● The FAIR principles ● Metadata: standards and documentation	FAIR principles Paper by Wilkonson et al. FAIR data introduction The FAIR principles Introduction to Metadata Documentation and Metadata Metadata Basics	Metadata standards Metadata workshop
4	8	**Open Data** ● Repositories ● Long-term storage / Sustainability ● Using and citing open data ● Data availability statements	Sharing and Archiving Data Citing data Planning for long-term use of biomedical data	Play the Data Horror Escape Room.
5	9	**Open Data** ● Legal Aspects and ethics ● Raw data vs. analysed data ● As open as possible as closed as necessary ● Anonymisation and data privacy ● Licensing	Ethics and data protection The art of data privacy (can be freely read online) Data privacy and anonymization Open Licensing and File Formats Licensing	Anonymise a data set Write a data management plan
5	10	**Open Source** ● Creating Project Repositories ● Collaborating via Repositories	Creating Project Repositories — The Turing Way	What makes software open source?

6	11	**Open Source** • Version Control with git	Version Control — The Turing Way	Start Starting out an open-source project
6	12	**Open Source** • Good coding practices • Simple practices for computational reproducibility	Good enough practices in scientific computing	Continue Starting out an open-source project
7	13	**Open Source** • Code Licensing • Maintenance and Sustainability	https://the-turing-way.netlify.app/reproducible-research/licensing/licensing-software.html Software Evaluation Guide Peer review for scientific open source Python packages	Finalize Starting out an open-source project
7	14	**Open Access (OA)** • Models of OA • Find OA resources • Digital object identifiers (doi) • Legal aspects of OA (using resources and publishing) • Licenses	Open Access The open access author What is Open Access? Open Licensing | FOSTER	Find OA resources CC licences
8	15	**Open Access (OA)** • Costs of publishing OA • preprints • alternative methods of publication	The Contemporary Guide to Negotiating the Author-Publisher Contract Ten simple rules to consider regarding preprint submission | PLOS Computational Biology 101 Innovations in Scholarly Communication: how researchers are getting to grip with the myriad new tools | Impact of Social Sciences	Author contract
8	16	**Open Peer Review** • Current review practices in academic • Open peer review • Give constructive critique	What is open peer review? A systematic review | F1000Research The open peer reviewer | FOSTER	Group discussion
9	17	**Open Peer Review** • Workshop on peer review		Group work
9	18	**Open Science Engagement in Academia and beyond** • Citizen Science • Creating collaborations and communities/networks/societies	CS support material: D3.3 Citizen Science Starters Kit (Online Citizen Science Training Materials) | Zenodo Student communities support: OSF More general societies/collabs: Guide for Collaboration — The Turing Way (the-turing-way.netlify.app)	Invidual or group work on Citizen Science Invidual or group work on collaboration and communities

10	19	**Open Science Engagement in Academia and beyond** • Scientific communication • Open Innovation	SC support: Guide for Communication — The Turing Way (the-turing-way.netlify.app) OI support: Open Science and Innovation | Open Science and Innovation (fosteropenscience.eu)	Invidual or group work on Scientific Communication Invidual or group work on Open Innovation
10	20	**Open Culture Change - Change Management (CM)** • Models of Change Management • Participants of CM • Components of CM (i.e. Participants, Tools, Skills, etc.) • Leadership types • Roadmaps	Activism Cultural Change PsyArXiv Preprints | The CO-RE Lab Lab Philosophy - Reading to be adopted to the required context Promoting Open Science: A Holistic Approach to Changing Behaviour | Collabra: Psychology | University of California Press (ucpress.edu)	First assignment of Roadmapping Project
11	21	**Open culture change - Policy and Research Assessment** • Current global open science policies • OS as global driver for science policy focus • Current assessment in our university • Research assessment reforms adopted by international universities • DORA - declaration of research assessment	Toolkit for policy makers on Open Science and open access (openaire.eu) UNESCO recommendations on Open Science Mutual learning to bring about systeming changes for open science, including creating a roadmap for open science Strategy Evaluation protocol used in NL	Policy checklist to assess OS readiness OS Roadmap project - Submission deadline and review Optional assignment - Science diplomacy online course
11	22	**Open Culture Change - Mentoring change in the system** • Coaching vs. mentoring overview • Coaching methodology • In-class coaching/mentoring	Detailed resource list for mentoring: Guide to Peer Support, Coaching and Mentoring (volunteeringact.org.au) Mentoring and Coaching (cimaglobal.com) Mentoring and Coaching: Chapter 19 – ScienceOpen - Mandatory, really good resource Recommendations for ECRs to improve research	
12	23	**Wrap-Up** • Presentation of final Roadmap		
12	24	**Wrap-Up** • Presentation of final Roadmap		Final Roadmaps due

Due to the interactive nature of this course, some flexibility in the exact topics covered is essential. Discussion of topics marked with an asterisk may be either abbreviated or removed altogether to allow extended class discussion of other key concepts.

POTENTIAL ASSIGNMENTS & EXERCISES

Introduction / Overview Lecture

1. Understanding Open Science - A Case Study

To gain an early understanding of the various pillars of open science, students are encouraged to evaluate the case studies presented here. In small groups, students can discuss the possible actions that can be taken in favor of open science in these cases.

2. Optional assignment - The Dilemma Game

In this game, students are confronted with difficult situations, providing them with chances to develop their principles surrounding open science before the course starts. Find the Dilemma card game here.

Open Methodology Module

1. Data management and Documentation

a. Reflecting upon the content of the lecture and recommended reading, students should reflect on the importance of opening methods used by researchers and making them publicly available.
https://royalsocietypublishing.org/doi/10.1098/rsos.200805
https://online.ucpress.edu/collabra/article/7/1/18684/115927/Easing-Into-Open-Science-A-Guide-for-Graduate
b. Reflecting on the graduates guide to open science, students should consider what steps they would take in their own research to implement such changes in their methodologies. What software, tools or strategies could students implement in their research which would improve data management and documentation?
c. Additionally reflecting on the data management plans and documentation strategies, students should consider what approaches or systems they may employ to further secure their data and findings.
https://www.mse.kit.edu/RDM.php

2. Workflows

a. After attending this lecture students should reflect upon their past or current

research studies: Could your work be replicated easily by another researcher?

b. Students should reflect on how they document the steps taken within their research methods and whether they feel there are changes which could be made.
https://pose.open.ubc.ca/open-research/open-workflows/what-is-an-open-workflow/#:~:text=What%20is%20an%20Open%20Workflow%3F%201%20Defining%20a,reproducible.%20...%203%20Workflow%20stages%20and%20tools%20

c. Students should consider the guide on creating a research workflow and review whether they feel it provides sufficient information for research replication. Developing_a_research_workflow_and_back-up_plan_for_your_work.pdf (udel.edu)

3. Preregistration and research protocols

a. Given what was reviewed in today's lecture students should consider what uses preregistration has not only for their study but for open science as a practice. https://www.frontiersin.org/articles/10.3389/fpsyg.2018.01831/full?fbclid=IwAR1Hq8GcLqqflz0ecoPSu7yxoX7A4Z8ujefu4AboAI8Lpc8NFYjYScyIB9k

b. As an exercise students will design and format a template which would suit their research for preregistration and define what approach they would take to initiate the process.

c. Considering research protocols students should review the attached public protocol and consider whether they feel it sufficiently accounts for and tracks the research developments.
https://how-to-open.science/share/open-protocols/
https://laneblog.stanford.edu/2020/06/01/open-science-tool-to-publish-protocols/
https://www.protocols.io/view/isolation-of-nuclei-from-frozen-tissue-for-atac-se-kxygxmr34l8j/v1

4. Open hardware and Exit Strategies

a. Given what was covered in today's lecture and the recommended readings- students review how they would adapt their current practices and record keeping to allow for improved data tracking and research contributions.

b. As an exercise students should recommend steps to be taken to ensure an adequate exit strategy can be put in place for research.
https://data.research.cornell.edu/content/use-data-exit-checklist-you-leave
http://ocsdnet.org/projects/hita-ordo-natural-fiber-honf-foundation/

Open Data Module

1. Personal definition of research data

Given what they learned in class, students should reflect on what they understand under the term “research data”. What type of data do they use and produce in their research, or is produced and used in their discipline or field. This self reflection can either be done outside of class or in-class. After the self reflection part, students discuss their personal definition with their peers (in class) and might adapt their definition accordingly. If time permits, the students’ definitions can be discussed in class with the instructor giving feedback.

2. Open Data Case Study and FAIR data (Optional)

To understand the value of open data for society, students (or groups of students) will go through a successful open data case study (for example from here: link) and present the stories to their peers. Optionally, if the students have a good open data case study to tell themselves, they can choose to do so. Further, the students can fill in the “how FAIR are your data” checklist with their own or a data/paper provided by the instructor.

3. Metadata standards

In this assignment the students will go through the list of metadata standards (link) to understand which of the standards is the most useful for them and their data. The definition of research data that the students wrote in the first assignment will help them. If possible, the students can write-up or summarize their own checklist with standards that are relevant for them. As for previous assignments this list of standards can be discussed with the peers and the instructor in-class.

4. Metadata workshop

For this assignment the instructor will put together a selection of examples of metadata with missing bits. For example would one example only have very basic data description, without clear description of the variables (units, …). In another example the data provenance would be missing. These examples would be shown to the students in class, before discussing all together what crucial elements are missing. The final part of the assignment entails writing metadata for a publicly available dataset selected by the instructor (or the students, if they are more senior researcher).

5. Anonymise a data set (Optional)

This assignment works best with students who already have experience with data processing. A (synthetic) dataset with personal data on individuals (names, birthdate,

birthplace, …) is used. The students will then discuss/discover what they have to do with the data to ensure that it is (pseudo-)anonymised: for example create an identifier for each individual and delete the name, group the individuals in age groups instead of showing their exact date of birth.

6. Write a data management plan

The instructor will present a study protocol for a study that plans to create some type of data. Depending on the audience and their field of study, protocols or preregistrations can be found on clinicaltrials.gov, the open science framework or others. In small groups, the students will then write a data management plan for the study. If the selected study has a DMP that is published and accessible, the instructor can choose to discuss it with the students. If applicable, the assignment can be adapted to allow students to write a DMP for their own research project(s), or create a DMP template for future projects. Special attention should be put on how to archive and license the data and how to ensure its long-term storage.

Open Source Module

1. What makes software open source?

In this assignment, students will evaluate existing projects of their choice under criteria of being open source. The project should be evaluated by the hard requirements of being open source, such as the license and unhindered availability of the source code, as well as by soft requirements and best practices, such as open development, community, pricing, documentation, coding best practices, packaging/installability, dependencies, etc.

2. Starting out an open source project

After revising an existing project, students should now turn to starting their own example project. They should pick an open-source license and detail the consequence of their choice as opposed to at least one other popular open-source license.
After this, they should create a Git repository on either a public platform such as GitHub/GitLab (or alternatively an instance hosted locally). The repository should be populated with the chosen license and a Readme file, and a Git Tag should be set for defining a first release version.
A list of next steps (beside actually writing the code) should be compiled (including packaging, documentation, testing and continuous integration/deployment).

Open Access Module

1. Find OA journals

Find journals and identify what OA models they offer. First, look at journals that you know about. Then use a database like DOAJ to specifically search for OA journals. Compare their OA offerings

2. Chose CC license

What are suitable CC licenses for publishing OA? What happens when different sources with different CC licenses are reused, remixed and published as a new work? Students can participate in a quiz and vote on the possibility to choose a certain combination of CC licenses. Afterwards there can be a discussion about why some combinations are allowed, while others are not.

3. Analyze author contract

Analyze an author contract on rights transfer and second publication rights. Are there embargo periods stated? Is it possible to publish a preprint during peer-review?

Open Peer Review Module

1. Group or peer discussion on constructive critique

Explore a few examples of (open) peer review and identify/collect issues or positive aspects about them. What are elements of constructive feedback?
How to Survive Peer Review
Peer Review – Best Practices : Broad Institute of MIT and Harvard

2. Group work - peer review

Depending on the structure of the group, the instructor might choose a few articles, e.g. from open-peer-review-journals like F1000Research or preprints that the group (or smaller subgroups) should collaboratively write a peer review on. Conduct a round of critique on the results.
How to Write a Peer Review - PLOS
PRECHECK: A checklist to evaluate COVID-19 preprints

Open Science Engagement in Academia and beyond

1. Individual or group work on Citizen Science

Identify a citizen science project to contribute to, or how you could adapt your own research to include CS. By the end of the assignment, the student should submit a short explanation on which project they chose, why, and how they would contribute to / implement it. Please check resources below/mirror board for CS project examples.

2. Individual or group work on collaboration and communities

Identify a community would like to participate or create. By the end of the assignment, the student should submit a short explanation on which community they chose, why, and how they would contribute to / implement it. Please check resources below/mirror board for OS communities examples.

3. Individual or group work on Scientific Communication

Create a blogpost / illustration / podcast episode on a scientific topic of interest. The student should submit a 2-page explanation (context, why, challenges faced) on the project, next to the material itself. Please check resources below/mirror board for SC examples.

4. Individual or group work on Open Innovation

Find examples of relevant Open Innovation projects and create a short pitch presentation to colleagues. A list of interesting resources / projects could be added to the final product. Please check resources below and on the Miro Board for Open Innovation examples.

Open Culture Change Module

1. Change Management

a. OS Roadmap Project

Students have to create a roadmap of their projects (research/structural reorganization) to include Open Science principles. Using the project management tools that the students have learnt through the course, they will have to design a first draft of the roadmap. Peers from the course will provide feedback on this roadmap draft, following which students will revise their roadmap and present it in the final wrap-up lectures.

The change management plan includes answers and diagrams to the following questions:

- What is the change desired? Identifying one aspect of change to implement or improve in the student's own work/environment

- Why is the change needed? Elaborating on the reason for implementing the change
- What is the expected outcome after the change?
- What resources do you need to implement the change? E.g. finances, people, expertise, tools, educational materials, etc.
- Who will be involved in the change process and how? All stakeholders who are involved and affected in the change process.
    - Who will be supporting you in the change process?
- What resistance is anticipated in the process and what is the course of action to counter resistance?
- What is the plan to make sure the change is integrated in the culture?
- What is the timeline to implement each stage of the change?
- What are major milestones to indicate progress?
- How will you measure success and effectiveness of the change?

Support resources for drafting roadmaps:

- Passport for Open Science - A Practical Guide For PhD Students (ouvrirlascience.fr)
- Easing Into Open Science: A Guide for Graduate Students and Their Advisors | Collabra: Psychology | University of California Press (ucpress.edu)
- Tool for roadmapping ClickUp™ | One app to replace them all

2. Policy and Research assessment

a. Open Science policy checklist

Using your research group/department/institute/university as an example, work through the open science policy checklist from OpenAIRE: open-science-policy-checklist-for-research-performing-organisations
Through this assignment, students will be able to assess the readiness of institutions to adopt open science policy and potentially assess areas requiring OS implementation.

b. OS Roadmap project - Submission deadline and review

Students will upload their roadmap into the assigned shared learning platform (such as moodle) to encourage their peers to review the roadmaps in preparation for the one-to-one peer mentoring in the following lecture.

c. Optional assignment - Science diplomacy online course

Influencing and implementing policy changes at different operational levels can help increase the current scope and implementation of Open Science policy. Towards this end, interested students can choose to take this online course in their spare time: European Science Diplomacy Online Course – EU Science

Diplomacy (s4d4c.eu). Completion of this assignment is not mandatory for the successful completion of this open science course.

3. Mentoring change into the system

a. One-to-one peer mentoring

Based on the mentoring and coaching skills discussed in this lecture, students will have to practise mentoring in a one-to-one fashion. In 20 min windows, students will mentor each other in developing the final version of their OS roadmap. In conversational style, students will take turns to provide feedback on the roadmap, tackling each prompt question to ensure a comprehensive overview. Please take this session to practise giving constructive feedback that can help your mentee fully develop their OS roadmap project.

Wrap up Lectures

Across two lecture, students will present the OS roadmaps that they have designed based on their understanding developed through the course material and one-to-one peer mentoring. Students will present their roadmap in ~6mins, discussing where they would like to increase and implement openness in their research project/environment. Audience members can also be encouraged to provide feedback in this stage, commenting based on their experience.

SUGGESTED RESOURCES

All of the resources listed here were curated to support the intent of this syllabus. You can also find these resources visualized into module blocks in the Miro board.

Intro / Overview

- https://www.orion-openscience.eu/public/2019-02/Researcher_Case%20Studies.pdf
- https://www.eur.nl/en/media/2020-12-original-dilemma-card-game

Open Methodology

- Easing Into Open Science: A Guide for Graduate Students and Their Advisors | Collabra: Psychology | University of California Press (ucpress.edu) - This article provides a beginners roadmap to assist graduate students and their advisors to engage in open science practices whilst carrying out their research.
- The case for formal methodology in scientific reform | Royal Society Open Science (royalsocietypublishing.org)
- **Open Hardware:** Open Science Hardware refers to science hardware that is open source - or free to use, change, study or distribute.

    - Home - Gathering for Open Science Hardware (openhardware.science)
    - ‘Open-hardware’ pioneers push for low-cost lab kit | Nature
    - Understanding Open Hardware and Citizen Science | OCSDNET
    - Open science hardware resources: Open science tools you should start using right now (peerrecognized.com)
- **Workflows:**
    - Open Research Workflow - Open Science - Research Guides at University of California Irvine (uci.edu)
    - This course introduces Open Source Software (OSS) management and workflow as an emerging but critical component of Open Science.
    - Open Source Software and Workflows | FOSTER (fosteropenscience.eu)
    - A presentation on research workflows in the context of open science. "Open Science: the National Plan and you",
    - NPOS Workflow-perspective-Bosman-Kramer.pptx (figshare.com
    - What is an Open Workflow? | Program for Open Scholarship and Education (ubc.ca)
    - Best Practices for Organizing Work | Program for Open Scholarship and Education (ubc.ca)
- **Electronic Laboratory Notebooks**
    - This article describes the advantages of using ELN's in enabling open science practice in the lab: Electronic Laboratory Notebooks (ELNs) as key enablers of open science - Publications Office of the EU (europa.eu)
    - Open laboratory notebooks: good for science, good for society, good for scientists - PMC (nih.gov
    - Template ELN :OSF | JHU Electronic Lab Notebook Template
- **Preregistration:**
    - Frontiers | How to Crack Preregistration: Toward Transparent and Open Science (frontiersin.org)
    - Preregistration (cos.io)
    - Methods (how-to-open.science)
    - International open science: A preregistration template for quantitative research in psychology (apadivisions.org)
    - On these sites you can find templates to follow as well as resources which outline various workshops, articles, materials and instructions on how to register your research plan in advance of your study
    - Preregistration is available across a variety of sites/journals some examples include the Open Science Framework, AsPredicted and Prospero.
- **Publishing Study Protocols**
    - Study protocols provide a record of a researcher’s plan of action, a study’s rationale, methodology and analyses. It ensures greater transparency in the research process.
    - Open Protocols - Open Science Knowledge Base (how-to-open.science)
    - Open Science Tool to Publish Protocols | Lane Library Blog (stanford.edu)

- **Data Management Plans:**
  - A DMP describes the data management life cycle for the data to be collected, processed and/or generated.
  - Research Data Management and Data Management Plans | FOSTER (fosteropenscience.eu) - a comprehensive breakdown of DMP for PhD students
  - OSF - a template DMP
  - Evaluation and analysis of Data Management Plan tools: A parametric approach - ScienceDirect
  - https://www.mse.kit.edu/RDM.php#Anker0
  - https://the-turing-way.netlify.app/reproducible-research/rdm/rdm-dmp.html?highlight=document
- **Data Exit Checklist:** https://data.research.cornell.edu/content/use-data-exit-checklist-you-leave
- **Workflows**
  - Open Research Workflow - Open Science - Research Guides at University of California Irvine (uci.edu)
  - This course introduces Open Source Software (OSS) management and workflow as an emerging but critical component of Open Science.
  - Open Source Software and Workflows | FOSTER (fosteropenscience.eu)
  - A presentation on research workflows in the context of open science. "Open Science: the National Plan and you",
  - NPOS Workflow-perspective-Bosman-Kramer.pptx (figshare.com
  - What is an Open Workflow? | Program for Open Scholarship and Education (ubc.ca)
  - Best Practices for Organizing Work | Program for Open Scholarship and Education (ubc.ca)
- **Open Qualitative Methodologies**
  - Checklist for qualitative researchers: Qualitative Open Science Practices | FORRT - Framework for Open and Reproducible Research Training
  - Integrating Qualitative Methods and Open Science: https://academic.oup.com/joc/article-abstract/71/5/855/6339986
  - Integrating Qualitative Methods and Open Science: Five Principles for More Trustworthy Research* | Journal of Communication | Oxford Academic (oup.com)

Open Data

- Games: https://community.data.4tu.nl/games/
- Overview:
  - https://www.fosteropenscience.eu/learning/managing-and-sharing-research-data/#/id/5b2ccc7d7ce0b17553f69063

    - https://open-science-training-handbook.gitbook.io/book/open-science-basics/open-research-data-and-materials
- FAIR data:
    - https://www.nature.com/articles/sdata201618
    - https://www.nature.com/articles/sdata201618
    - https://www.go-fair.org/fair-principles/
    - https://dmeg.cessda.eu/Data-Management-Expert-Guide/1.-Plan/FAIR-data
- Metadata
    - https://www.getty.edu/publications/intrometadata/
    - https://the-turing-way.netlify.app/reproducible-research/rdm/rdm-metadata.html
    - https://www.dublincore.org/resources/metadata-basics/
    - http://rd-alliance.github.io/metadata-directory/standards/
- Repositories: Sharing, archiving, sustainably
    - https://fairsharing.org/
    - https://the-turing-way.netlify.app/reproducible-research/rdm/rdm-sharing.html
    - https://nap.nationalacademies.org/read/25707/chapter/1
- Legal aspects: licensing, privacy
    - https://the-turing-way.netlify.app/reproducible-research/licensing.html
    - https://dmeg.cessda.eu/Data-Management-Expert-Guide/5.-Protect
    - https://open-science-training-handbook.gitbook.io/book/open-science-basics/open-licensing-and-file-formats
    - https://rss.onlinelibrary.wiley.com/doi/epdf/10.1111/1740-9713.01608
    - https://datascienceinpractice.github.io/tutorials/08-DataPrivacy%26Anonymization.html
- Other
    - https://nap.nationalacademies.org/read/18998/chapter/1
    - https://nap.nationalacademies.org/read/25214/chapter/1
    - https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1003542

Open Source

- Repositories
    - Videos:
        - https://www.youtube.com/watch?v=7Oq81K27NmU
        - https://www.youtube.com/watch?v=AggJQTgsaaU
    - https://the-turing-way.netlify.app/project-design/project-repo.html
    - Example of contributing guidelines: https://github.com/alan-turing-institute/the-turing-way/blob/main/CONTRIBUTING.md
    - https://the-turing-way.netlify.app/reproducible-research/compendia.html#rr-compendia

- Version Control & Git
    - https://the-turing-way.netlify.app/reproducible-research/vcs.html
    - https://swcarpentry.github.io/git-novice/
    - https://docs.google.com/presentation/d/1xNtZ3CU_bdqIiI2sD6xqP7A8p2Yc3AhsnehYGnf_4k4/edit
- Best Practices
    - 6 Steps Towards Reproducible Research
    - https://goodresearch.dev/
    - https://carpentries-incubator.github.io/good-enough-practices/
- Sustainability
    - https://www.software.ac.uk/resources/online-sustainability-evaluation
    - https://f1000research.com/articles/9-295
    - Licensing https://the-turing-way.netlify.app/reproducible-research/licensing.html

Open Access

- https://openaccesseks.mitpress.mit.edu/
- https://kups.ub.uni-koeln.de/53745/
- https://www.openaire.eu/
- UNESCO's Open Access (OA) Curriculum is now online
- https://zenodo.org/record/5787046
- Open Access Fortbilden
- https://digital.csic.es/handle/10261/229536
- https://www.coar-repositories.org/resources/
- https://www.fosteropenscience.eu/node/2220
- https://www.fosteropenscience.eu/node/2415
- https://libguides.reading.ac.uk/open-research/introduction
- https://wb-web.de/material/medien/die-cc-lizenzen-im-uberblick-welche-lizenz-fur-welche-zwecke-1.html
- https://www.fz-juelich.de/en/zb/open-science/open-access/open-access-monitor
- https://blogs.lse.ac.uk/impactofsocialsciences/2015/11/11/101-innovations-in-scholarly-communication/
- https://open-access.network/en/information/open-access-primers/what-does-open-access-mean
- https://rs.cms.hu-berlin.de/uag_fdm/pages/search.php
- https://www.coalition-s.org/
- https://zenodo.org/record/3966478
- http://rescience.github.io/
- https://scholar.archive.org/
- https://www.health-ri.nl/data-stewardship-handbook-hands
- https://doaj.org/

Open Peer Review

- https://www.precheck.site/
- https://www.fosteropenscience.eu/learning/open-peer-review/#/id/5a17e150c2af651d1e3b1bce
- https://ag-openscience.de/open-peer-review/
- https://f1000research.com/articles/6-588
- https://plos.org/resource/how-to-write-a-peer-review/
- https://www.fosteropenscience.eu/node/2224
- https://openreview.net/
- https://f1000research.com/articles/7-969/v1
- https://mitcommlab.mit.edu/broad/commkit/peer-review/
- https://eurodoc.net/ambassador-training/m4-open-peer-review
- https://f1000research.com/for-referees/peer-reviewing-tips/examples
- https://libraries.ou.edu/content/establish-your-expertise-open-peer-review
- https://plos.org/resource/open-peer-review/
- https://researcheracademy.elsevier.com/navigating-peer-review/certified-peer-reviewer-course
- https://masterclasses.nature.com/online-course-on-peer-review/16507836
- https://rdcu.be/c9h1t
- https://authorservices.wiley.com/Reviewers/journal-reviewers/becoming-a-reviewer.html/peer-review-training.html

Open Science Engagement in Academia and beyond

- Communities
    - The Turing Way https://the-turing-way.netlify.app/index.html
    - Open Innovation in Life Sciences | Switzerland https://www.openinnovationlifesciences.com/
    - ReproducibiliTeahttps://reproducibilitea.org/
    - International Network of Open Science & Scholarship Communities https://osc-international.com/
    - Café Guix https://hpc.guix.info/events/2022/caf%C3%A9-guix/
    - Mission https://studentinitiativeopenscience.com/mission-2/
    - Netzwerk der Open-Science-Initiativen (NOSI) https://osf.io/tbkzh/wiki/home/
    - (no title) https://improvingpsych.org/
    - FORRT - Framework for Open and Reproducible Research Training https://forrt.org/
    - OLS https://openlifesci.org/
    - Open Science Freelancers https://open-science-freelancers.gitlab.io/about/
    - Open Research Calendar https://openresearchcalendar.org/

    - Become an Ambassador https://www.cos.io/communities/ambassadors
    - Network of Open Science Grassroots Networks https://groups.google.com/a/cos.io/g/network-of-open-science-grassroots-networks

- Citizen science
    - Citizen Science Lab https://www.universiteitleiden.nl/en/citizensciencelab
    - Citizen Science https://education.nationalgeographic.org/resource/citizen-science/
    - European Citizen Science Association https://www.ecsa.ngo/
    - Citizen Science https://science.nasa.gov/citizenscience
    - About - Citizen Science Association https://citizenscience.org/about/
    - What is Citizen Science - SciStarter https://scistarter.org/citizen-science
    - Über uns | Bürger schaffen Wissen https://www.buergerschaffenwissen.de/ueber-uns
    - CitizenScience.gov https://www.citizenscience.gov/#
    - Computer games https://www.orion-openscience.eu/publications/training-materials/202110/computer-games
    - Citizen Science: Innovation in Open Science, Society and Policy on JSTOR https://www.jstor.org/stable/j.ctv550cf2
    - EU-Citizen.Science https://eu-citizen.science/
    - Zooniverse https://www.zooniverse.org/

- Science Communication
    - Science Communication Resources - Science Through Story https://www.sciencethroughstory.org/scicomm/resources
    - Science Communication https://www.edx.org/course/science-communication
    - Designing Effective Science Communication https://www.coursera.org/learn/designing-effective-science-communication
    - RESOURCES | Earth Leadership https://www.earthleadership.org/resources
    - Science Communication: A Practical Guide | Science, Technology, and Society | MIT OpenCourseWare https://ocw.mit.edu/courses/sts-034-science-communication-a-practical-guide-fall-2011/
    - Science Communication and Public Engagement Course - FutureLearn https://www.futurelearn.com/courses/science-communication-for-researchers
    - Science Journalism Initiative https://erc.europa.eu/apply-grant/science-journalism-initiative
    - Who we are - ENJOI - Science communication https://enjoiscicomm.eu/who-we-are/
    - Science Communication Resources for Scientists | Marine Biological Laboratory https://www.mbl.edu/news/science-communication-resources-scientists

    - Scientific Utopia: I. Opening scientific communication https://arxiv.org/abs/1205.1055

- Open Innovation
    - opnMe https://www.opnme.com/
    - NI4OS Training Platform: Log in to the site https://training.ni4os.eu/mod/scorm/view.php?id=66
    - Start - InCube https://incubechallenge.com/start/
    - The Concept of Openness https://www.futurelearn.com/info/courses/openness-in-science-and-innovation/0/steps/349960
    - Open Science & Innovation - Einstein Center for Neurosciences Berlin https://www.ecn-berlin.de/open-innovation-153/open-science-innovation.html

Open Culture Change Module

- OS Policy and policy guidelines
    - Open Science https://research-and-innovation.ec.europa.eu/strategy/strategy-2020-2024/our-digital-future/open-science_en
    - Entscheidung Detail | Bundesfinanzhof https://www.bundesfinanzhof.de/de/entscheidung/entscheidungen-online/detail/STRE202210142/
    - EU Science Diplomacy https://www.s4d4c.eu/
    - UNESCO Recommendation on Open Science - UNESCO Digital Library https://unesdoc.unesco.org/ark:/48223/pf0000379949.locale&#61
    - Open science at the science-policy interface: bringing in the evidence? - Health Research Policy and Systems https://health-policy-systems.biomedcentral.com/articles/10.1186/s12961-022-00867-6
    - Toolkit for policy makers on Open Science and Open Access https://www.openaire.eu/toolkit-for-policy-makers-on-open-science-and-open-access
    - Open Science Policy Checklist for Research Performing Organisations https://www.openaire.eu/open-science-policy-checklist-for-research-performing-organisations
    - https://unesdoc.unesco.org/ark:/48223/pf0000383710
- Research assessment
    - The Commitments - COARA https://coara.eu/agreement/the-commitments/
    - DORA https://sfdora.org/read/

    - Research Assessment https://scienceeurope.org/our-priorities/research-assessment/#:~:text=Research%20assessment%20must%20reward%20all
    - Open Science Training Courses https://www.fosteropenscience.eu/toolkit
- Bringing effective culture change
    - Implementing Open Science | LERU https://www.leru.org/publications/implementing-open-science
    - Easing Into Open Science: A Guide for Graduate Students and Their Advisors https://online.ucpress.edu/collabra/article/7/1/18684/115927/Easing-Into-Open-Science-A-Guide-for-Graduate
    - Ten things every open-science culture-change agent needs to know about https://openscientist.pubpub.org/pub/h1wu3k75/release/2
    - LEADING TEAMS | Earth Leadership https://www.earthleadership.org/leading-teams
    - Becoming a Changemaker https://www.changemakerbook.com/
    - Unite! presents its strategic roadmap towards open science in the digital age https://www.unite-university.eu/unitenews/unite-presents-its-strategic-roadmap-towards-open-science-in-the-digital-age
    - Open Science as Part of Research Culture. Positioning of the German Research Foundation https://zenodo.org/record/7194537#.ZC2KjpHP1Ak
    - APA PsycNet https://psycnet.apa.org/record/2019-17055-001
    - 5 Critical Steps in the Change Management Process | HBS Online https://online.hbs.edu/blog/post/change-management-process
    - The CO-RE Lab Lab Philosophy https://psyarxiv.com/6jmhe/
    - Promoting Open Science: A Holistic Approach to Changing Behaviour https://online.ucpress.edu/collabra/article/7/1/30137/119214/Promoting-Open-Science-A-Holistic-Approach-to
    - Incentives to adopt open science practices in your daily research https://www.phdnet.mpg.de/2020-07-07-open-science-in-daily-research
    - Implementing Open Science Into Your Research Practices https://studentinitiativeopenscience.com/2021/04/28/implementing-open-science-into-your-research-practices/
    - The Change Management Process: What Is It and Who Is It For? https://www.coursera.org/articles/change-management-process
    - Cultural Change https://the-turing-way.netlify.app/ethical-research/activism/activism-cultural-change.html?highlight=change%20manage
    - Mentoring and Coaching : Chapter 19 https://www.scienceopen.com/hosted-document?doi=10.47622/9781928502616_19

Data Sources for Assignments/Exercises

- Welcome to the ReproHack Hub https://www.reprohack.org/paper/
- Find Open Datasets and Machine Learning Projects | Kaggle https://www.kaggle.com/datasets
- Social Sciences Replication Project http://www.socialsciencesreplicationproject.com/
- Reproducibility Project: Psychology https://osf.io/ezcuj/
- Experimental Economics Replication Project https://experimentaleconreplications.com/

Appendix

- https://www.ukrn.org/disciplines/
- https://openscientist.pubpub.org/dash/overview