



Guide for researchers to implement **FAIR Workflows**

Conventional research practice tends to focus on research articles and withhold the procedural documents, supporting datasets, and other relevant materials generated during the research process. However, the limitations of this approach have become increasingly apparent due to phenomena such as 'publish or perish,' the reproducibility crisis, and instances of academic fraud. In response, the research community is advocating for greater accountability, transparency, and openness. This call is being met by various initiatives across disciplinary domains, all aimed at making research data and supporting resources FAIR: findable, accessible, interoperable, and reusable. In this guide, we outline steps researchers can take to share all their research outputs with PIDs and metadata to make their research process and practices FAIR.

Benefits of incorporating FAIR Workflows

Collaboration: Science thrives on collaboration. Even when working independently, your research can benefit others. Sharing work, processes, results, and providing context to make them FAIR are the initial steps toward fostering successful collaboration.

Crediting: Every stage of research merits recognition. By showcasing the extensive work throughout the research process, including creating tangible outputs and attributing them to the individuals and organizations involved, we can effectively acknowledge contributions and demonstrate impact.

Compliance: Adhering to best practices is essential. Planning and executing each stage of research with the FAIR principles in mind helps navigate policies and requirements from institutes, funders, and collaborators. This proactive approach streamlines data sharing, reporting, and preservation efforts.

Central to achieving FAIR and Open research are persistent identifiers (PIDs). These identifiers and their associated metadata play a crucial role in each aspect of FAIR, through facilitating the discoverability, provenance tracking, and preservation of research outputs. By utilizing PIDs and standardized metadata in the sharing process, researchers can effectively describe and connect their outputs, thereby enhancing their FAIRness.



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A primer of the FAIR principles for researchers

Making scholarly works Findable involves making them available as scholarly records, ensuring they can be indexed and searched. The most comprehensive index for scholarly works is generated from DOI metadata.

Making scholarly works Accessible entails providing a pathway to make the work available to others. This can be achieved by depositing the work in a scholarly repository or utilizing platforms that host works and facilitate DOI registration for completed works.

Making scholarly works Interoperable means to describe them with standardized metadata and create meaningful links among related works so that they can be incorporated into different settings – this can be done by indicating relationships to other works during the sharing/deposition process.

Making scholarly works Reusable indicates to provide sufficient context for each individual work so that it can be understood and responsibly applied in subsequent research – this requires outputs be annotated with licensing, provenance, and community standards information in the PID metadata.

In order to align with the FAIR principles, it's crucial for researchers to make certain research objects, typically hidden away, available as reusable outputs.

The DOI and metadata created in the submission and sharing process is what makes an output FAIR. DOI metadata describes the work itself, and enables connections to related people, organizations, and funding through their corresponding PIDs. The PID infrastructure supports interoperability and facilitates discoverability of scholarly resources on a global scale – and makes diverse types of scholarly works easily citable.

FAIR sharing through the stages of the research project

	WHY The goals of sharing outputs in this stage	WHAT Sharable outputs and examples of supporting tools and platforms	HOW Workflows to ensure FAIRness of shared outputs
PROJECT PLANNING	Create points of reference through which all relevant outputs of the project can be linked and discovered	PROJECT PAGE E.g. Open Science Framework	Use tools/platforms that are integrated with open infrastructure to create and share outputs
	Provide a shared understanding for expected FAIR practices in the project	DATA MANAGEMENT PLAN E.g. DMP Tool ARGOS	Register DOIs for each output Use PIDs to reference related people, organizations, and resources in the metadata
METHOD PLANNING	Increase credibility and create guardrail against bad practice	PREREGISTRATION E.g. Open Science Framework	All of the above, and
	Enhance reproducibility and reusability through the implementation of domain specific metadata standard	METADATA TEMPLATE E.g. CEDAR Workbench	Reference the project and/or DMP in the DOI metadata when registering new outputs
EXPERIMENT & ANALYSIS	Follow up on the registered activities and mark deviations	EXPERIMENTAL PROTOCOL E.g. protocols.io	All of the above, and
	Create robust records to supplement research outcome	ANALYSIS CODE AND SOFTWARE E.g. Zenodo	Reference corresponding registration in the DOI metadata when registering new outputs
	Credit all contributors in the research process	DATASET E.g. Dryad	Create references among related data/code/protocol in the metadata
DISSEMINATION	Expedite dissemination of project outputs	PREPRINT E.g. PsyArXiv bioRxiv	All of the above, and
	Invite community engagement and feedback	PRESENTATION E.g. Zenodo Figshare	Cite shared outputs by their DOIs in manuscripts and presentations
	Lower barriers to access	PAPER E.g. ChronosHub	

The checklists below lay out steps to make research outputs FAIR using PIDs and metadata. They are arranged by the main stages of the research process. Check the different actions to take in order to: create key points of reference for people, organizations, funding; keep authorship, contributorship unambiguously acknowledged; establish relationships among outputs to provide contexts for reuse; and cite the outputs the same way literature is cited in publications.

Researchers can use them to identify steps to take, and tick these off once taken. Although consistent PIDs usage is encouraged, depending on the type of study, availability of the tools, and other factors, not all steps will apply to all research projects.

Commonly used PIDs



www.doi.org
DOIs for most types of research outputs.



www.orcid.org
ORCID iDs for researchers and contributors.



www.ror.org
ROR IDs for research hosting or funding organizations.

PROJECT PLANNING

The project planning stage is the perfect time to create a list of the resources available, such as researchers, facilities, and source of funding, and to outline the works that will be generated. Keeping track of these entities and their corresponding PIDs ensures they can be consistently acknowledged, referenced to, and credited throughout the project.

- ☐ All researchers in the project have ORCID iDs
- ☐ All organizations involved in the project have ROR IDs
- ☐ The project itself has a DOI
- ☐ A DOI (DMP ID) is registered for the data management plan
- ☐ A DOI is registered for the grant or award that funds the project
- ☐ ORCID iDs of researchers and ROR IDs of organizations are linked to the project and DMP
- ☐ The grant ID is linked to the DMP ID and the project ID
- ☐ If the project is an extension of a previous project, it is referenced in the project metadata
- ☐ If the project will reuse existing datasets or other resources, they are cited in the DMP

EXPERIMENT AND ANALYSIS

The protocol, notes, data, codebook, and processing workflows generated between the start of data collection and the delivery of the final analysis outcome are key products of any research study.

- ☐ A DOI is registered for each dataset produced in response to the preregistration
- ☐ A DOI is registered for the experimental protocol
- ☐ All contributing researchers are acknowledged in the specific outputs they worked on, using their ORCID iDs, with appropriate contributor roles
- ☐ Acknowledge the instrument or facility used in the experiment in the protocol metadata
- ☐ Link the dataset, analysis code, and results to their corresponding preregistration
- ☐ If shared separately, link the protocol, dataset, analysis code and results to each other
- ☐ Link the dataset, code, and other resources back to the DMP (by either updating the DMP or reference the DMP ID in the output metadata)
- ☐ If the protocol used in the experiment and analysis is adapted from an existing protocol from a separate project, cite the original protocol in the new one
- ☐ If the analysis reused a software package shared by other researchers, cite the software in the derived dataset

METHOD PLANNING

Making methodological decisions is pivotal, and it can yield key outputs that will be important points of reference throughout the research process by the project team and beyond. Notably, the best practice for any research methods involving hypothesis testing is to create a detailed research plan and share it in a registry, to make it accessible and citable.

- ☐ A DOI is registered for the study registration/experiment plan detailing the methods for data collection, treatment, and analysis
- ☐ A DOI is registered for the newly created tools, standards, or procedure that support the proposed methods
- ☐ The creators, contributors, and supervisors of methodology are acknowledged in the method document metadata through their ORCID iDs.
- ☐ The umbrella project is referenced in the study registration metadata through its DOI
- ☐ If the experiment reuses protocol/methodology documents, they are referenced in the experiment
- ☐ If multiple registrations are created, they are linked to one another using appropriate relation type metadata
- ☐ If the study registration describes an analysis that uses existing datasets or protocols, they are cited in the registration

DISSEMINATION

Engaging with the research community to stimulate discussions is an integral part of the research process, and it starts well before the manuscript has been published.

- ☐ Make important communication materials (poster, presentation, recording) presented to the peer community publicly accessible and identified with a DOI
- ☐ A DOI is registered for the preprint
- ☐ Acknowledge the authors, presenters, and contributors to the poster/slides/recording, using their ORCID iDs, with appropriate contributor roles
- ☐ Acknowledge the grants in the preprint and publication DOI metadata
- ☐ Acknowledge the researchers in the specific output they worked on, using their ORCID iDs, with appropriate contributor roles
- ☐ Link the preprint to the project/registrations it reports on
- ☐ Link the preprint to the manuscript when submitted to a journal
- ☐ Cite the key datasets and software cited in the preprint and formal publication