

cultural change towards the open science paradigm.

5. Foster collaboration with relevant stakeholders and networks

Funders should take the lead in bringing together researchers, research institutions policy makers, data managers, publishers, in view of developing aligned policies and sustainable strategies and infrastructures for open access to research data.

Research Institutions

Research institutions refer to universities and higher education organizations engaged in primary or secondary research and to publicly and privately funded research institutes/centres. Research institutions hold a focal role in transitioning to open access practices, as the primary loci where researchers carry out and publish their work. In recent years, research institutions around the world have been promoting the uptake of open access practices, as shown in the steadily increasing number of relevant policies. Nonetheless, the main focus thus far has been on open access to publications rather than research data and a comparatively small number of institutions has developed policies for research data management. Motivation to develop policies derives from institutions' need to safeguard their intellectual, financial, human and material investment, as well as the increasing pressure from research funders who require that research data produced with their funding is properly managed and openly accessible. In some cases, the motivation for developing a sound institutional data strategy derives from researchers, who acknowledge the significance of research data and the need for better management.

The most consistent progress in research data management is observed in the UK, the USA and Australia. Rapid developments both in the UK and the USA are mostly the result of funder mandates: Research Councils UK and the National Science Foundation and the National Institutes of Health in the USA. In Australia, while the policy of the main funding agency is not mandatory for research data, universities have made significant progress in addressing research data management under the influence of the Australian Code for Responsible Conduct of Research, requiring an institutional data management policy.

An effective data policy sets the pace and the requirements by which the research community within the institution is to abide. Such policy should allocate in a clear way responsibilities and tasks to the different actors within the institution, with researchers carrying the obligation to manage their research data to specific standards and the institution assuming the obligation to provide the services (infrastructure, training etc.) that will in turn allow researchers to comply with the policy requirements. While the allocation of responsibilities for each stakeholder is important, policies should be flexible enough to accommodate for the changes in researchers' needs and keep pace with technological developments. Institutional policies share a number of other common elements: they recognize the significance and value of research data and high standards for their management; they set open access to research data as the default, where this is appropriate and legally possible; they require researchers to develop a DMP; they render researchers responsible for the data management within their project; they acknowledge the need to respect funder requirements. Furthermore, they set requirements regarding where to deposit research data and outline broadly the data retention policy/strategy of the institution.

Developing and implementing a data management policy and developing relevant services is a team effort requiring the collaboration of multiple actors. The main ones are the research office, the IT departments, the academic units, the libraries and the researchers. When it comes to developing services, the university library and the IT department are those mostly involved in operationalizing policies: i.e. the development of the technical infrastructure and its services, the training for the researchers and advocacy services. It is common that IT departments undertake the software and infrastructure development, while the library supports archiving, training and advocacy activities. In developing data management services institutions need to consider which services should be developed in-house and which may be outsourced, on the basis of an assessment of their needs and resources. With respect to infrastructures, while in general they are more developed as compared to the associated policy frameworks, dedicated research data repositories are not widespread among research institutions.

Institutional policies for data management and open access to research data should be accompanied by relevant funds. In particular, funding is necessary both for data management during the life cycle as well as for the curation and preservation of data in the long term as in some cases research

institutions are seen as the 'obvious' place to host data, while in others they might constitute the only viable option given the patchy coverage of subject-specific data repositories or other data services. Yet, as external funding is usually limited to the lifetime of research projects, research institutions must increasingly turn towards finding resources for the long-term management and preservation of their output in research data.

In terms of training, formal training is necessary for researchers, as well as for librarians and information professionals in order to transition to open access to research data and a culture of open science more generally. While researchers in some fields may require training because they lack the knowledge and the skills on how to make their research data available and accessible, or how to reuse data and incorporate data in their research process, librarians and information experts require training for providing research data services that are necessary in an increasingly data-intensive research environment. Thus, workshops, as well as formal training programmes and curricula that enable data management skills, data-intensive research, and the gradual development of data-scientists are important activities for research institutions to engage in.

Finally, further progress is needed in terms of rewarding researchers for good data management and providing open access to research data. Currently there is little, if any, formal recognition for data outputs in academic promotion or other assessment processes, which inhibits progress towards open access to research data.

Recommendations

1. **Develop an explicit institutional research data strategy with open access as the default position**

Consultation and collaboration with the research community is critical in understanding their needs and in developing the necessary infrastructure and services. The establishment of committees within institutions that will work in close collaboration with funders and the research communities will alleviate significant pressure from researchers and accommodate disciplinary practices.

2. **Actively pursue collaborations between and within institutions in fostering a sustainable ecosystem and infrastructure for open access to and long-term preservation of research data**

Developing relevant services requires the collaboration among different institutional departments within an institution. It further requires research institutions to evaluate their current capacities and collaborate with other institutions and centers of expertise in providing services and enabling a sustainable and scalable scholarly communications ecosystem.

3. **Include open access to high quality research data as a formal criterion for career progression**

Formal acknowledgement of research data as a legitimate output is expected to bring gradual change in practices. Such formal recognition should be accompanied by the development and use of metrics that allow the collection and tracking of data use and impact.

4. **Develop educational and training programmes for researchers and staff to improve data management skills and to enhance data-intensive research**

In designing such programmes research institutions should pay attention to disciplinary specificity and practices, while avoiding one-size-fits-all solutions. In doing so, research institutions can explore the possibility of developing joint courses with data managers, especially data

centers, and across different specialties.

5. Raise awareness about the benefits of open access to research data and provide rewards

Focusing on awareness-raising and advocacy activities, as well as rewarding researchers are necessary tools to this end. Awareness and advocacy activities can have different formats, such as seminars, webinars, brochures, leaflets etc., and should be explored in combination with the development of training programmes for researchers.

6. Support the research community through the provision of legal and ethical advisory services

Research institutions may systematically support their researchers in addressing legal and ethical challenges raised by open access to research data by deploying specific instruments (e.g. committees, formal training) to develop new and common solutions to issues such as licensing, privacy and confidentiality, among others.