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# Gaps in Open Science Support in Europe: Disciplinary Perspectives from the EOSC Future Project

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**V. 1**

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## Executive Summary

As a platform for progressing European research and promoting interdisciplinary exchange, the European Open Science Cloud (EOSC) aims to meet the various disciplines at their level of readiness and skill in practising Open Science by providing the necessary and targeted supports for encouraging greater engagement and collaboration. EOSC Future is an EU-funded H2020 project designed to give European researchers access to a wide web of FAIR data[1] and related services through the implementation of the EOSC. There are three pillars to this work:

> 1) improve and develop EOSC-CORE services enabling the operation of EOSC; 2) build an EOSC Interoperability Framework to provide guidelines for users and service providers who want to contribute to EOSC, and register and integrate these services from research infrastructures, other EOSC projects and science clusters; and 3) ensure that development meets the expectations and needs of EOSC users, particularly the design and functionality of the EOSC Portal.[2]

This report has been prepared for the EOSC Future project as part of task 10.2.1 "Widening EOSC awareness and engagement in underrepresented communities", which aimed to provide insight into the challenges facing users of EOSC working in thematic research areas which are not as well-supported or engaged in the pursuit of Open Science. It summarises the issues that emerged over the course of the project in interviews, surveys, focus groups, and conference presentations with participants from disciplinary communities that were perceived to be underrepresented. It should be noted that this report also includes the perspectives of some communities that are better supported by EOSC, in the hope that raising awareness about common challenges will pave pathways to shared solutions.

It is important to note that while this report includes references to overarching policies being developed to guide cross-disciplinary and international participation in Open Science, the work herein is not an effort to align policy-making or develop technical interoperability support and guidance. There are other efforts underway guiding and socialising those developments. It is also beyond the scope of this report to prescribe or recommend an Open Science development plan for the disciplines discussed. The success of EOSC will largely depend on culture change among researchers towards openness, which is fundamentally something that must come from within the communities themselves rather than imposed top-down by policies, providers, or funders. Finally, this report is not meant to judge or compare one community's progress towards Open Science by contrasting it with the successes of adjacent communities, although the successes of those neighbouring communities may be foregrounded in the choice of tools, standards, repositories, or other resources accessed by those underrepresented in EOSC currently.

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[1] Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18
[2] "Ambitions," (2021-2024) EOSC Future. https://eoscfuture.eu/about/ambitions/

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**Gaps in Open Science Support in Europe: Disciplinary Perspectives from the EOSC Future Project**

# 1. Introduction

One of the key aims of the Open Science movement is to facilitate the sharing of knowledge across boundaries, thereby making "scientific research, data and dissemination accessible to all levels of an inquiring society."[3] Yet what has emerged from research disciplines now engaging with Open Science is a diverse landscape populated by highly tailored and specific infrastructures, schemas, guidance, training, and support mechanisms which require considerable effort to describe and share intelligibly outside of the community silos in which they were created. As disciplinary capacity for data sharing continues to mature unevenly, the diversity of approaches will only present greater challenges in facilitating access to reusable data if steps are not taken to address the root causes of uneven development. Coordination and effort is necessary to leverage the proliferation of platforms and tools, funding sources and policy measures, to both meet the needs of diverse research communities and ensure the interoperability of data and associated tools, environments, and outputs. Therefore identifying and addressing the issues that prevent some disciplines from fully engaging in data sharing is an essential step in advancing the aims of Open Science.

## 1.1 Common themes

In carrying out research across the disciplines, some common themes emerged from the consultations which may usefully inform future approaches to engagement and Open Science pedagogy in any discipline, and are outlined below. Some of these issues were presented and discussed in a Research Data Alliance community call dedicated to disciplinary data, with a summary available in Zenodo.[4]

**There is a baseline awareness of Open Science across the disciplines that can be built on.** The concept of Open Science appears to be generally well socialised across the academic research areas surveyed, even if, in one interviewee's assessment, it exists mainly as a 'buzzword'. It is at least understood as something that benefits research and the research process generally, with early career researchers and graduate students being more accepting of data sharing and Open Access publishing as desirable and beneficial outcomes for their research practices. This baseline awareness of Open Science also extends to the FAIR principles, similarly suggested by the results of the 2022 Digital Science Report in which a wide range of researchers surveyed reported roughly the same level of awareness of the FAIR principles across the disciplines, with more noticeable deviation when it came to being familiar enough to apply them.[5]

**Challenge:** All disciplinary representatives reported, however, that there was a lack of understanding and support for putting the principles into practice. In our study, this translated into an overall assessment of a **low general awareness of the application of Open Science best practices, including the FAIR data principles,** in the disciplines represented (Fig 1).
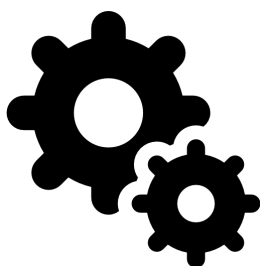
**FAIR enabling tools are becoming more readily available across the disciplines, but there is often not equitable access within the disciplines.** The majority of respondents felt there was good or acceptable access to resources and tools for data sharing, suggesting that most domains have good access to the technical resources needed to create and share FAIR data (Fig 2). Even thematic communities which had low or moderate levels of awareness of Open Science practice generally had some acceptable access to technical solutions that could be used by a wide range of communities (for example, Electronic Lab Notebooks), even if those solutions were designed for adjacent domains.

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[3] Facilitate Open Science Training for European Research (FOSTER). https://www.fosteropenscience.eu/taxonomy/term/7.

[4] Knazook, Beth. (August 2023). RDA for Disciplinary Data Cross-Community Fertilisation Workshop Summary. Zenodo. DOI: 10.15497/RDA00098.

[5] Science, Digital; Goodey, Gregory; Hahnel, Mark; Zhou, Yuanchun; Jiang, Lulu; Chandramouliswaran, Ishwar; et al. (2022). The State of Open Data 2022. Digital Science. Report. https://doi.org/10.6084/m9.figshare.21276984.v5

**Challenge:** Tools developed for specific disciplinary audiences with narrow applications may be used by other disciplines with different needs, but it often requires trailblazing individuals to demonstrate how to utilise them in ways that support the interoperability of outputs across those disciplines. Where those tools or services are not fully open due to geographic or other resource limits, researchers unable to access these tools may struggle to provide data that is fully interoperable with that produced by the popular tools.

### Open Science has a cost that not everyone can afford.

Disciplinary interviewees reported different levels of frustration with the labour and financial cost of data sharing. Making a dataset FAIR, or publishing an article or book via Open Access routes, may cost the researcher both time and money for things such as proprietary tools, publisher's fees, or access to expertise (such as hiring a data steward). Some researchers have better access to funds or institutional support which offset these costs, but in all disciplines there is a sense that doing Open Science has personal costs.

**Challenge:** The reasons for avoiding the extra labour of data sharing that emerged from this investigation would suggest that the absence of incentive and reward are not the only problems. Clear workflows for tools, as well as ease of access to repositories for storing the output from those tools, made researchers much more likely to share, although even in the best conditions issues like technology churn can create an additional burden. Where researchers cannot align on a tool, because of the heterogeneous nature of research in a field, data sharing requires the development of unique solutions for each new project. Repeated investment in a practice that should be made easier over time can be a big discouragement.

This reflects similar observations from a report on the progress of disciplinary communities towards Open Science in American higher education produced by Ithaka S+R, which found that "Absent strong incentive and reward structures, researchers are often reluctant to take on this "extra" labor."[6] Better recognition of the effort required to participate in Open Science is clearly needed within academic career pathways and funding models, but actually easing the costs are critical to widespread adoption.
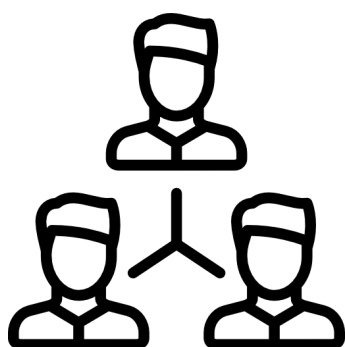
### EOSC is viewed most positively as a collaboration space, but this value is being imagined by users who are still unclear how to benefit from this value.

Most of the disciplines surveyed struggled with collaboration, even in circumstances where there was some consensus around tools and standards. As noted above, when the burden of sharing is reduced there is a higher likelihood of participation, but that does not necessarily mean that researchers immediately look for existing data to reuse at the start of a project or that they can easily work with others who cannot share their data fully openly. Where collaboration happens, it is sometimes executed under constraints which limit possible collaborating partners. Big data projects rely on collaboration more than disciplines that typically work with smaller datasets, leaving small data projects less well supported in this goal.

**Challenge:** Increasing recognition of the importance of collaboration has influenced perceptions of EOSC, and specifically the EOSC Portal, as a collaboration space that cuts across disciplinary and geographic borders. When asked "What is your general impression of EOSC?" respondents had generally positive statements about EOSC as a communication and innovation hub, contrasted with a high degree of uncertainty about current functionality, perceived to be limited to a discovery service and publishing platform (Fig 5). Supporting

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[6] Ruediger, D. *et al.* (9 Aug 2022) "Leveraging Data Communities to Advance Open Science," Ithaka S+R. https://doi.org/10.18665/sr.317145.

engagement with underrepresented communities will require EOSC to provide clear communication about its potential to support collaboration.

**1.2 Discipline-specific takeaways from underrepresented communities**
Community information sheets aimed at disciplinary researchers in eight thematic communities were created using the information gathered for the Widening Engagement task, and these highlight particular challenges to data sharing along with EOSC-specific solutions.[7] The following summary highlights key discipline-specific takeaways gathered from discussion with community representatives in those disciplines determined to be underrepresented in EOSC.

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**KEY TAKEAWAYS FROM UNDERREPRESENTED DISCIPLINES**

**Biodiversity** The field of Biodiversity deals with organisms that move across borders or have a global distribution, and has benefitted from the leadership of globally-focused communities of practice that recognise the importance of data exchange to a global ecosystem. While collaboration is important to the field, project-specific agreements can also limit data sharing. Biodiversity still lacks uptake in standards that promote interoperability and needs more support for training in this area. As more researchers connect with global infrastructures, the more successful the field is becoming.
View the disciplinary info sheet for Biodiversity

**Chemistry** Work in the lab is still manual, and collaboration tends to happen only in small, localised groups. Replicating data does not have a high cost so there is less of a need to seek out existing data before proceeding with research. There are some community-driven initiatives that are encouraging the interoperability of chemistry standards and repositories with other disciplines. Chemistry will benefit from more collaboration with adjacent disciplines, such as Biology and Materials Sciences, in leveraging its development of standards and emerging successes from select sub-disciplines.
View the disciplinary info sheet for Chemistry

**Materials Sciences and Engineering** Precise characterisation of materials and other samples requires diverse experimental and computational approaches, but much of the discipline still relies on manual workflows which are hard to translate to digital tools and platforms. Repositories and community resources are being developed, but collaboration is hindered by siloed funding and inward-focused, location-specific research cultures. Open Science uptake is motivated by a few people keen to do things properly and to show others how they succeeded.
View the disciplinary info sheet for Materials Sciences and Engineering

**Wind Energy** Digitization is both easing and speeding up collaboration, as well as making research results more accessible, but the community has yet to rise to the challenge of making these resources truly reusable by creating FAIR data frameworks, connecting people and data to foster innovation, and enabling collaboration and competition between organisations. Since industry is such an important source of data in this field, researchers are often afraid to share outside of their projects without clear guidance on how to share. Collaboration models need to change, which refocus on standardisation and sharing through common repositories, with important changes needed in research culture towards social solutions.

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[7] Meeus, S., Mendes, P. S. F., Roemer, J. K., Knazook, B., Sitz, L., Andreassen, H. N., Cebecauer, M., & Mitrea, G. (2023). RDA/EOSC Future Disciplinary Information Sheets. Zenodo. https://doi.org/10.5281/zenodo.10026059

## 2. Background and methodology

An important goal for EOSC Future task 10.2.1 was to examine the social barriers that hinder disciplinary progress in engaging with Open Science generally, and EOSC in particular, leveraging the RDA membership as a volunteer-driven, global community of engaged professionals aware of the issues and opportunities in their fields of research. The task builds upon work carried out by the RDA, Digital Repository of Ireland (DRI), and Digital Curation Centre (DCC) under RDA4EOSC in which the 'awareness' and 'readiness' levels of selected communities engaging with EOSC were assessed according to a number of technical and social indicators perceived to be enabling the progress of Open Science across their respective fields. Several communities were flagged as either unaware or unprepared to participate in EOSC, indicating that they may either be operating in data silos, wherein their data is harder to exchange with other disciplines because of a lack of standardisation, support, or unequal access to resources and tools; or that the discipline as a whole is simply not yet participating in Open Science to an extent that has demanded an investment in resources and support (in other words, disciplines which are operating in the so-called 'long tail of science'[8]). In the report compiled from this work, [RDA4EOSC: Supporting the engagement of disciplinary research communities with the European Open Science Cloud](#), it was observed that "social indicators or aspects are harder to assess and more challenging than the technical aspects as these bring together individual and organisational aspects and formal and informal structures that are difficult to evaluate." Any efforts to add to our understanding of the social indicators would therefore be of benefit, and the RDA provides a rich resource for varied, personal input from data experts well-versed in the Open Science movement.

The 2021 RDA4EOSC report evaluated the awareness and readiness of thematic communities to engage in Open Science based on the development of standards, policies, guidance, and roadmaps alongside investment in infrastructures and core services, repositories, and other technical resources in the European landscape.[9] Through that research, it was shown that certain disciplines were taking action to support researcher engagement in Open Science via the European Open Science Cloud, and it was suggested that this provision of support would be a critical indicator of disciplinary uptake. In this study, information-gathering focused more on researchers as users of services and infrastructures, rather than producers, in an effort to identify the potential barriers to realising EOSC as a user-centred research data commons.[10] As a result, the new levels of awareness presented here may be more reflective of whether higher-level decision making has yet had an impact on the ground.

### 2.1 Target audience

The research activity undertaken for this report was intended to inform the development of the [European Open Science Cloud](#), and it is anticipated that the summary provided here could be usefully incorporated into ongoing work in the EOSC Association. The [Research Data Alliance (RDA)](#), as a partner in EOSC Future and supporter of EOSC, will also leverage these findings to inform future activities around organisational support for disciplinary community groups.

### 2.2 Selecting the disciplinary communities for review

Within the EOSC Future project, RDA launched 2 rounds of [RDA/EOSC Future Domain Ambassador calls](#) seeking Domain Ambassadors to provide targeted outreach for the thematic communities they represent. It was decided that this task would also take advantage of those calls in accessing domain experts. The [second round of Domain Ambassador funding calls](#) specifically targeted the same domains that were evaluated by the earlier RDA4EOSC report in order to build on the information already available, with particular attention paid to recruiting those communities that were flagged as RED or underserved by EOSC. This current report relies heavily on input gathered from consultations with the Domain Ambassadors as well as the RDA membership more broadly.

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[8] The concept of the 'long tail of science' generally "refers to the large number of individual researchers and small laboratories who do not have access to dedicated computational resources and online services to manage and analyse large amount(s) of data." [https://www.digitalinfrastructures.eu/content/serving-long-tail](https://www.digitalinfrastructures.eu/content/serving-long-tail)

[9] As indicated by the recommendations for research communities in the European Commission, Directorate General for Research and Innovation & EOSC Executive Board. (15 Feb 2021) Strategic Research and Innovation Agenda (SRIA) of the European Open Science Cloud. Version 1.0. [https://www.eosc.eu/sites/default/files/EOSC-SRIA-V1.0_15Feb2021.pdf](https://www.eosc.eu/sites/default/files/EOSC-SRIA-V1.0_15Feb2021.pdf).

[10] European Commission, EOSC Declaration. 26 October 2017. [https://eosc-portal.eu/sites/default/files/eosc_declaration.pdf](https://eosc-portal.eu/sites/default/files/eosc_declaration.pdf).

Table 1 Disciplines represented by RDA/EOSC Future Domain Ambassadors

| Domain | Ambassador's specific thematic area | Community colour code from previous report (if applicable) |
|---|---|---|
| Biodiversity | Biodiversity | Red |
| Chemical Sciences | Catalysis | Red |
| Cultural Heritage | Cultural Heritage* | Orange |
| Earth, Space and Environmental Sciences | Earth, Space and Environmental Sciences and Arctic Research Data Community | Green |
| Health Sciences | Life sciences computing and personal medicine | Green |
| Linguistics | Linguistics | Green |
| Materials Sciences | Materials Sciences and Engineering | Red |
| Wind Energy | Wind Energy* | Red |
| Ethnic and Migration Studies | Ethnic and Migration Studies | n/a |
| Life Sciences | Life Sciences and Standards, Repositories and Policies | n/a |
| Microbial Ecology | Microbial Ecology | n/a |
| Philosophy | Ethics & Law | n/a |
| Social Sciences | Social Sciences | n/a |

*No Wind Energy Ambassador was recruited, but an RDA/EOSC Future Grantee selected for a different open call was willing to participate and discuss Open Science practices in their discipline. Cultural Heritage is also included in this list as that is a particular area of expertise for the DRI, the organisation acting as task lead.

Each of these thematic communities can be recognised as distinct communities of practice, which are:
● Represented in EOSC on some level, either by research infrastructures and/or thematic services, with outputs that appear in the EOSC Portal;
● Have had some services, tools or training developed specifically for them; and,
● Have at least one representative within the RDA with the expertise to comment on EOSC resources and support for their discipline.

**2.3 Consultation tools**
● *User Experience Sessions (3 sessions, 20 participants)*
  ○ Starting with EOSC Future User Group, User Experience sessions were held to introduce the users to the new Portal design.
  ○ Users were asked to rate their experience of EOSC prior to the session, and to perform a specific search within the Marketplace related to their disciplinary research area.
● *Survey (207 respondents, 4 in-depth follow-up consultations)*
  ○ A survey was conducted of the RDA membership aimed at gauging the global awareness of EOSC. The survey was open to members from January 16 – Feb 28, 2023, and was promoted via the RDA social media, website, newsletter, and related community communication channels.
  ○ Focus groups were formed from a cohort of 39 volunteers from the RDA membership, but ultimately had very poor attendance. The team decided to pursue follow-ups as one-on-one interviews rather than continue with group sessions.
● *One-on-one interviews with Domain Ambassadors (15 interviews)*

- Semi-structured interviews with [EOSC Future/RDA Domain Ambassadors](), as well as representatives who opted to participate in interviews or focus groups via the RDA survey, were conducted from December 2022 – June 2023.
- Attendees were invited to discuss the current state of the data community and the perceived barriers to Open Science. Meetings were held over zoom in one hour intervals.

- *RDA Plenary meeting (hybrid attendance, 28 attendees registered their participation in the session's shared Google doc)*
  - A joint Interest Group/Working Group meeting hosted by the FAIRsharing Registry: Connecting data policies, standards and databases RDA WG, Professionalising Data Stewardship IG, Engaging Researchers with Data IG, and Early Career and Engagement IG was held at RDA P20 in Gothenburg, Sweden (March 2022), *[Community Engagement that Works!]()*. Past and current Domain Ambassadors were invited to present their challenges and successes in engaging their communities, followed by a discussion from several RDA groups focused on outreach, training, and engagement.

**2.4 Assessment criteria**

Still using the traffic light system established by the earlier report, the 'awareness' and 'readiness' levels were evaluated separately this time, as follows, in an effort to answer the question "*Is awareness the problem?*"

Table 2 An evaluation guide

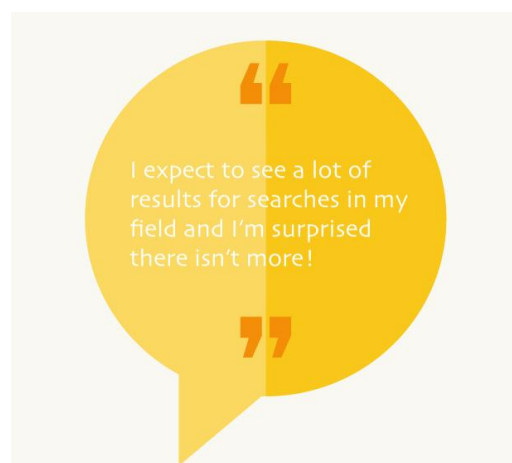| Awareness of Open Science practices and guidance | |
|---|---|
| Red | Unaware, early stages for advocacy or policy development guiding practice |
| Orange | Somewhat aware, few resources available to inform practices, some community advocacy and guidance available |
| Green | Aware, able to access to policies, training and guidance, community advocacy for best practices |
| Availability of Open Science tools and infrastructures | |
| Red | Unprepared, no access to FAIR-enabling technologies, tools or infrastructures (or uneven and limited access to some researchers) |
| Orange | Somewhat prepared, some access to FAIR-enabling technologies, tools or infrastructures |
| Green | Prepared, easy access to appropriate technical supports and infrastructures, and FAIR-enabling technologies and tools |

**2.5 Limitations**

The observations presented here document the individual perceptions of those working within different disciplinary frameworks, and it should be acknowledged that the information collected will reflect various specific geographic and political frameworks, levels of education, funding, and relationships with non-academic partners (e.g. industry, government, the arts, etc.).

## 3. Summary of findings

The information collected between December 2022 and July 2023 was acquired to supply individual perspectives on specific issues hindering selected disciplines from wider engagement in Open Science.

**3.1 User Experience sessions**

This activity sought to discover if disciplinary considerations need to be taken into account when designing platforms that aid discovery of data resources.

> I prefer boolean search over filters; I'd rather retry my search than to try and refine a big pool of results.

> I expect to see a lot of results for searches in my field and I'm surprised there isn't more!

*3.1.1 The EOSC Future User Group*

User Experience sessions were planned using the [EOSC Future User Group](#) to determine if there are differences in disciplinary user approaches to the Marketplace that might be leveraged in writing targeted guidance for certain research communities. User Group participants were divided into 3 groups with approximately 20 participants per group, although only two of the groups went forward. These groups aligned users by disciplinary affiliation: Humanities and Social Sciences participants in one group and Physics, Chemistry and Engineering in another group. Users were also selected to reflect geographical diversity, a range of experience (from new researchers to established ones) and different levels of familiarity with the EOSC Portal (from participants who were well aware of the Portal to those who have never used the Portal before).

*3.1.2 The RDA/EOSC Future Domain Ambassadors*

A modified version of the original User Experience session was presented to the RDA/EOSC Future Domain Ambassadors on 27 June 2023, with input from WP5. The goal was again to gather information about potential differences in disciplinary approaches to the EOSC Portal while also introducing the Domain Ambassadors to the technical improvements provided through EOSC Future, helping them to better articulate the benefits and value of EOSC to their research communities.

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**KEY TAKEAWAYS (USER EXPERIENCE SESSIONS)**

While there were not enough participants to draw broad conclusions about disciplinary preferences versus individual preferences, there are some interesting observations that align with expectations about differences in disciplinary engagement with Open Science.
For instance,

- Humanities users are likely more adept at using keyword combinations to return data and publications, finding less of a need to filter results than to broaden them.
- There is some indication that the new design of the EOSC Portal is more friendly to science users. Researchers in the science domains were overall more comfortable with the EOSC Marketplace search and filters, while Social Sciences researchers found the content jumbled and less useful, and were more likely to restart a failed search than use filters to navigate.
- The overall design of the Portal seems more tailored to disciplines with a high volume of data sharing, and who therefore expect to find a wealth of data on a particular topic and a need to

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### 3.2 RDA Survey and Focus Groups

A survey was issued to the RDA membership in January 2023 aimed at understanding the global awareness of the European Open Science Cloud (EOSC). The purpose of the survey was threefold:

- Assess the awareness of EOSC in the larger, global Open Science landscape;
- Identify existing and potential community pathways and good practices from the global perspective, in order to develop engagement mechanisms for EOSC, resulting in a report and practical support materials;
- Identify respondents willing to participate in follow-up activities.

It consisted of 11 brief questions and at the end respondents were asked whether they would like to participate in a focus group to help produce an assessment of the value that EOSC contributes to disciplinary engagement in Open Science. There were 207 responses to the survey, with the majority (136) located in the EU, and an additional 31 located within Europe but outside of the EU.

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**Survey questions and responses**

**Q1. What region do you work in?**

69% (136) respondents work in the EU region

31% (64) of respondents work exclusively outside the EU region

7% (14) respondents work in more than one region


**Q2. What is your primary role?**

42% (87) of respondents describe themselves primarily as researchers

50% (104) work in research support areas


**Q3. What is your primary research area?**

36.7% (76) respondents were from the Natural Sciences

70% (34) out of a total of 48 Frascati research areas were represented

At 1.9% (4), Agriculture was the least represented discipline


**Q4. If applicable, please describe your narrower field or sub-discipline speciality.**

Respondents were asked to provide more granular information about their research discipline with 124 choosing to do so. In total 118 unique sub-disciplines were mentioned.


**Q5. Have you ever used the EOSC Portal, received promotional information about EOSC through disciplinary or social networks, or received training about EOSC?**

47% (97) had used the EOSC Portal or been targeted in training and communications about EOSC

Of those that answered no, 13% (27) clarified that they were aware of EOSC or had visited the EOSC Portal

37% (36) of those who had engaged with EOSC also worked with cross-disciplinary research


**Q6. If you answered yes to the question above, please indicate your level of experience with EOSC.**

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41% (40) said they were somewhat experienced / familiar with services and tools provided by EOSC
55% (53) have an awareness of EOSC or have visited the EOSC Portal
Only 4% (4) said they were very experienced or knowledgeable of EOSC

**Q7. What communities of practice or networks (outside of the RDA) are you aware of in your research area (e.g. BiomedExperts)?**
62% (129) participate in communities that support their research areas
46% (96) have access to discipline-specific community supports

**Q8. Do you use, or are you aware of any domain specific repositories that accept data, software, or publications from your field of research (e.g. JRC Nanomaterials repository, DANS)?**
If yes, please name them.
29% (61) responded with disciplinary specific repository options for their fields
31% (67) named national or generalist repositories, or resources that were not actually repositories

**Q9. If you use domain specific tools for your research (e.g. GCRI, Hivebench, LabArchives), please describe how access is provided (i.e. through your university library, through networks, from a website, etc.)? Are there any limitations on that access (cost, number of users, researcher affiliation, etc.)?**
57% (118) did not answer the question
*Of those that answered the question:*
21% (19) accessed resources through the university library
7% (6) used websites that required institutional or project affiliated logins
19% (17) used open access tools

**Q10. This question is about cross-disciplinary research.**
**Do you utilise tools, repositories, or social networks that originate from disciplines other than your primary research field? If yes, how do you access those resources? Are there limitations on that access (cost, number of users, researcher affiliation, etc.)?**
52% (109) did not answer the question
*Of those that answered the question:*
70% (69) utilise resources from other disciplines, often looking to multidisciplinary tools (like Zenodo or Github, 12%) or those developed by neighbouring disciplines
29% (28) identified the following limitations: relying on collaborators, university or research consortia subscriptions, limited-access repositories, restricted social networking tools, user logins required

**Q11. Would the creation of an RDA group to discuss data solutions for your disciplinary research community be valuable?**
35% (72) respondents indicated that they did not currently have a discipline-specific representation within RDA and think a group in their discipline would be helpful. See
🗓 RDA Disciplinary Group requests .

### 3.3 One-on-one interviews

Through a series of semi-structured interviews, RDA/EOSC Future Domain Ambassadors and select RDA/EOSC Future Grantees answered a series of questions about disciplinary engagement generally in Open Science:

- *Where do you think the pain points are for your discipline when it comes to Open Science and data sharing? What are the disciplinary struggles?*
- *What are the successes?*
- *What of the following (services, standards, policies, networks) have really supported participation in Open Science?*
- *What is your general impression of the European Open Science Cloud? If you had to explain to someone what EOSC was, what would you say?*
- *Are you aware of the new services and features that are coming as a result of the EOSC Future project?*
- *Which of these features do you think would make the most impact in terms of reaching researchers in your discipline?*

These questions were used as prompts but not all interviewees engaged with each prompt. There was also time allocated within the interview to explain EOSC Future activities so that the Ambassadors could more confidently connect the project's goals to their own objectives. A summary of the interview responses is also available here: 🗓 EOSC Interview and Survey Results .

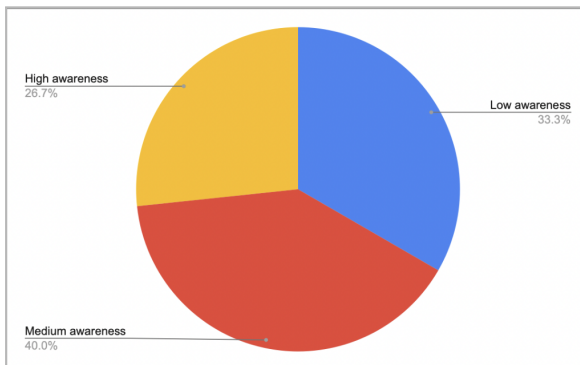## KEY TAKEAWAYS (INTERVIEW QUESTIONS)



*Fig 1 The majority of interviewees characterised their domain's awareness of Open Science practices as low/medium.*
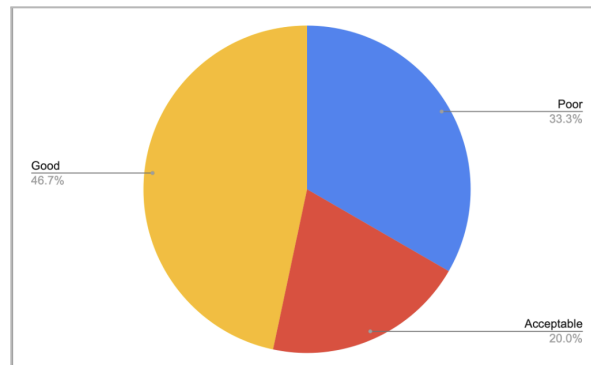


*Fig 2 The majority of interviewees characterised the availability of Open Science tools and resources as good/acceptable.*
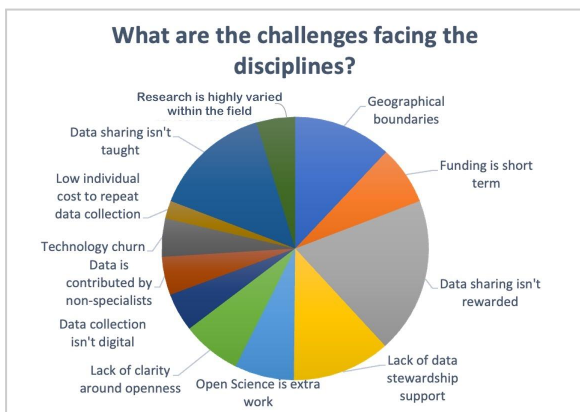


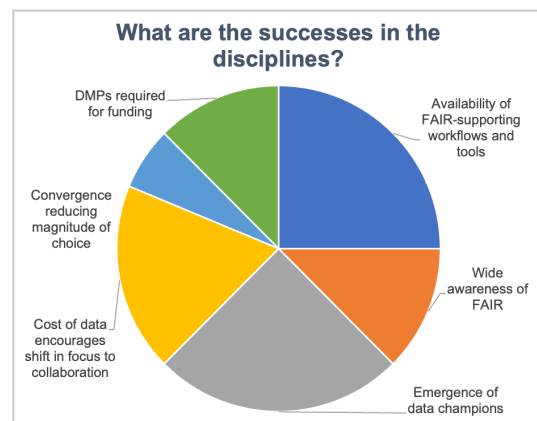*Fig 3 Challenges reported in engaging researchers with Open Science*



*Fig 4 Successes observed in engaging researchers with Open Science*
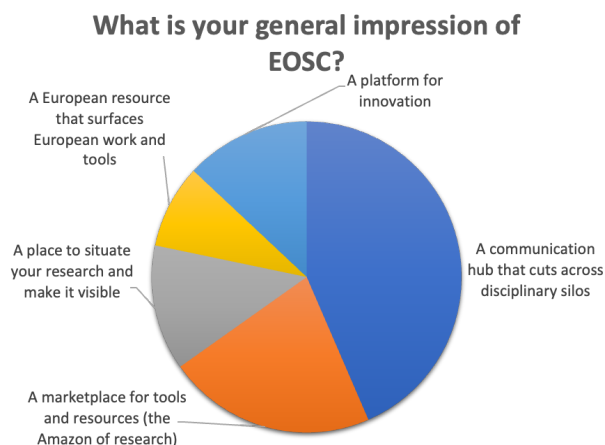


*Fig 5 Summary of RDA/EOSC Future Domain Ambassador responses to the question "What is your general impression of EOSC? If you had to explain EOSC to someone, what would you say?"*

**3.4 Research Data Alliance Plenary meetings**
RDA P21 Plenary session Community Engagement that Works! Examining tools and success stories of pathways to Engagement in Community-led organisations at a global level focused on the challenges to disciplinary advocacy work. Current and former Domain Ambassadors were invited to fill out cards describing engagement successes and challenges specific to their disciplines. Two representatives from national networks outside of the EU also participated. Chairs from the FAIRsharing Registry: Connecting data policies, standards and databases RDA WG, Professionalising Data Stewardship IG, Engaging Researchers with Data IG, and Early Career and Engagement IG led the discussion that followed on Visibility and Outreach, Measuring effectiveness and uptake, and Sustainability.

Issues raised:
- Difficulty reaching the right people
- Lack of sustainable investment and funding for international harmonisation of FAIR
- EOSC and other Open Science platforms currently lack specific structures and tools for addressing ethics and law
- Lack of funding to support bottom-up initiatives by young, motivated researchers
- Difficulty distinguishing between national and international requirements and strategies
- Difficulty finding diverse representation to support outliers
- Hard to demonstrate impact with existing metrics

**KEY TAKEAWAYS (RESEARCH DATA ALLIANCE PLENARY)**
- Recognition of the importance of coordinated community engagement (and the importance of Community Engagement Managers as sustained rather than ad hoc positions with clearly defined roles).
- Community building often starts with volunteers working with specific, defined audiences. When resistance to advocacy efforts are encountered, those volunteers might feel there's nowhere to turn for support. The RDA should be the place to turn for encouragement and reassurance.
- There should be methods in place to provide benefits for people involved in community engagement work. Monetary help provides that tangible benefit, but short term funding needs to be followed by ways to sustain ongoing engagement. Projects should make space for community engagement as a valuable output in its own right.
- There is a clear benefit to both the RDA and the European-funded Domain Ambassadors to provide space within the RDA to continue to connect post-funding, and to provide insight and guidance for successful outreach and engagement activities to potential future globally funded ambassadorships.

## 4. Addressing the Challenges

Examining the factors that underlie the successes that some disciplines have had in moving towards a majority of Open Science adopters (Table 3) reveals that those communities underserved by EOSC are the ones that would most benefit from EOSC as a platform for collaboration and communication. These thematic communities lack professional support in the form of funded data stewards, targeted training opportunities, and access to an active community of practitioners. On the other hand, what mostly all disciplines do have are a few 'data champions' (trailblazing individuals adapting and modelling good research practice for others), as well as access to some level of disciplinary community support or international communities of practice like the Research Data Alliance.

Table 3 Factors indicating disciplinary success and their presence in underrepresented communities

| Supporting Factor | Wind Energy | Materials Sciences | Chemical Sciences | Biodiversity |
|---|---|---|---|---|
| Collaboration | Yes | No | No | No |
| Individuals modelling good research practice | Yes | Yes | Yes | Yes |
| Community group support | No | Yes | Yes | Yes |
| Open science education is a required part of academic training | No | No | No | No |
| Data stewardship funding and policy support | Yes | No | No | Yes |
| Infrastructure support | No | No | Yes | Yes |

Moving underrepresented communities from a few, motivated trailblazers to widespread adopters of good practice takes enormous investment in individual effort. Taking a discipline further from a population of 'early adopters' to an 'early majority' requires making data sharing easy and expected: easy, in the sense that it becomes a reasonably low-labour effort to carry out because the workflows and processes do not need to be reinvented or reimagined for each new research project, and expected, in that the researchers are trained in current best practices, have access to the needed data stewardship support, and their career pathways recognise the skills that come from this labour.

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**RECOMMENDATIONS**

*These recommendations are targeted to the EOSC Association and RDA communities, as key stakeholders in the work carried out for the report.*

- **Empower individuals to raise awareness around specific applications of practice**
  Low awareness around best practices is not caused by low interest or a lack of perceived value in Open Science generally. A lack of participation in Open Science may rather result from unclear communication on how to apply general advice to specific situations, and an absence of education and training opportunities targeted to particular applications. Many researchers simply do not know where to look for advice that is applicable to their work.
- **Promote, reward, and fund data reuse, not just data collection and generation**
  Data reuse is not yet widely encouraged as part of good research practice, particularly in those fields where there is a low barrier to re-collecting certain types of data, repeating experiments, or running the same analyses. Grant applications from major funding bodies now broadly encourage the creation of Data Management Plans (DMPs) that identify data deposit and data sharing as outcomes of funded research projects, but there is not yet a major focus on rewarding the reuse of existing data—except perhaps in the case of big data projects. Researchers are more mindful of the environmental costs of big data, where it is easier to see how not sharing hinders the progress of science. Advocacy efforts that highlight the benefits of sharing small data is also needed.

- **Reward collaboration at any scale**
  EOSC has the potential to be an essential, cross-disciplinary communication hub that can help collaboration at any scale succeed, but there are global and financial barriers that need to be overcome before the developing technical and social mechanisms can be fully utilised. In addition, some researchers rely on the contributions of those outside of academia, who are not trained in their specific disciplinary methods. Making Open Science community resources and training accessible to all improves the usefulness of the scientific outputs for everyone.
- **Provide equitable access to FAIR enabling tools and quality data sources**
  EOSC aggregates contributions from providers that are not always accessible to everyone, making it difficult to share across borders let alone across disciplines. If certain tools have emerged as the best technology for a particular need, those tools should be made as equitably accessible as possible.