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Abstract

This report presents a collection of seven case studies describing how FAIR competences are being addressed through education and training programmes. The good practices offer examples of successful integration of Research Data Management (RDM) and FAIR data-related skills in university curricula and training to provide an up-to-date perspective on how these skills are being implemented by higher education institutions. This report provides universities with points of inspiration and practical examples of how fellow institutions and organisations in the higher education sector addressed the need for more RDM and FAIR data-related skills to be taught at the bachelor, master and doctoral levels. It does so by analysing external and internal drivers, steps for the implementation, invested capacity and the impact reached by the good practices.

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1. Introduction

1.1. Background and objectives

The application of FAIR (Findable, Accessible, Interoperable and Reusable) principles[1] to data is increasingly becoming an important part of the production and sharing of scientific knowledge. In recent years, the FAIR Data Principles have gained traction as a key enabler for the transition to Open Science competence, as the alignment of practices with the principles helps to ensure that outcomes of research activities are ready to be shared and, if the right conditions exist, reused, thus contributing to the transparency and openness of the whole research process. Developing new training activities and support actions to broaden the acquisition and uptake of FAIR data skills in the university community therefore plays a strategic role in fostering the implementation of FAIR research data management (RDM) as an established practice at the institutional level. FAIR data skills pertain to the broader context of data science skills and data stewardship skills, where the former refers to the "ability to handle, process and analyse data to draw insights from it"[2] and the latter to "a set of skills to ensure data are properly managed, shared and preserved, both throughout the research lifecycle and for long-term preservation".[3] FAIR data also feed into a broader policy discussion at the national and European levels, where new initiatives have been formulated to promote their widespread use and implementation.

This report presents a collection of case studies describing how FAIR competence is being embedded in educational programmes. In this analysis, the term "competence" refers to "an element (topic) of theory or practice [...] combined with an expertise level to indicate whether someone has an awareness of the area, or an ability to do it, or expert knowledge of it"[4]. Good practices presented in this report offer examples of successful integration of RDM and FAIR data-related skills in university curricula and training across the different levels to guide and inspire universities interested in developing their own teaching and training initiatives to support the acquisition and uptake of data-related skills.

While the experiences and details of the case studies differ, the good practices stem from the same need: equipping students, doctoral candidates and other researchers, as well as the university staff, with the skills and competences needed to make their data FAIR. Currently, the lack of FAIR data-related skills is one of the challenges hindering the implementation of RDM

[1] Wilkinson, Mark D., Michel Dumontier, Ijsbrand Jan Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg, et al. 'The FAIR Guiding Principles for Scientific Data Management and Stewardship'. *Scientific Data* 3, no. 1. Retrieved on 20 October 2021, from: https://doi.org/10/bdd4.
[2] European Commission. "Turning FAIR into Reality: Final Report and Action Plan from the European Commission Expert Group on FAIR Data". Electronic resource. Luxembourg: Publications Office, 2018, p. 13. Retrieved 10 December 2021, from: https://op.europa.eu/s/poVD
[3] Ibid., p. 13.
[4] EOSCpilot (2018), FAIR4S. EOSCpilot framework of FAIR data stewardship skills for science and scholarship, and draft recommendations on FAIR training. Retrieved on 15 December 2021, from: https://www.eoscpilot.eu/sites/default/files/fair4s_eoscpilot_skills_framework.pdf

and FAIR data practices at the institutional level.[5] Higher education institutions are therefore seeking opportunities to enhance their training provision for FAIR education. Creating more opportunities for FAIR data education is indeed instrumental to the definition of a more responsible and sustainable research lifecycle. A broader uptake of FAIR data-related skills is also needed to support the university community in complying with new regulations and requirements from the institutional, national and European levels.

This report was developed in the framework of the Fostering FAIR Data Practices in Europe (FAIRsFAIR) project[6], which aims to develop and supply practical solutions to support the implementation and use of the FAIR data principles throughout the research data lifecycle. In particular, the report feeds into the efforts of the project's Work Package 7 (WP7) which focuses on "FAIR Data Science Curricula and Professionalisation".

Since the start of the project, WP7 partners have been working to analyse and develop strategies in support of the embedding of FAIR data-related skills into university curricula. The following paragraphs retrace the main steps of the work undertaken by the members of WP7 during the project, highlighting the different deliverables produced and how they contributed to achieve the project's objectives.

A landscape analysis of the state of play of FAIR data education in Europe was conducted in 2019, through a survey targeting university rectors and vice-rectors responsible for research activities from European higher education institutions. The results revealed major challenges related to the implementation of RDM and FAIR data practices, in particular a low awareness among students and researchers, a widespread lack of skills and insufficient training opportunities. In addition, while the survey report[7] highlighted how policies regulating research data were increasingly being adopted by universities, these tended to recommend rather than mandate the performance of RDM and the alignment with the FAIR data principles. Taken together, these challenges hinder the development of a FAIR data culture at the institutional level. Universities responding to the survey expressed a clear interest in addressing these issues and putting a stronger focus on FAIR data-related competences and practices in curricula and teaching, recognising, at the same time, the need for practical tools that could support them in this process.[8]

Desk research was also conducted to analyse the landscape of FAIR data resources and initiatives available in Europe. The resulting report provided an overview of eight existing

[5] Morais, R., Saenen, B., Garbuglia, F., Berghmans, S., & Gaillard, V. (2021). From principles to practices: Open Science at Europe's universities. 2020-2021 EUA Open Science Survey results. Retrieved on 20 October 2021, from: https://eua.eu/resources/publications/976:from-principles-to-practices-open-science-at-europe%E2%80%99s-universities-2020-2021-eua-open-science-survey-results.html.
[6] More information about the FAIRsFAIR project is available here: https://www.fairsfair.eu. Retrieved on 20 October 2021.
[7] Stoy, L., Saenen, B., Davidson, J., Engelhardt, C., Gaillard, V. (2020), "D7.1 FAIR in European Higher Education". Zenodo. Retrieved on 20 October 2021, from: https://doi.org/10.5281/zenodo.5361815.
[8] Ibid.

competence frameworks in the field of data stewardship and Open Science, as well as different training activities addressing RDM and FAIR data skills.[9]

This analysis provided a reference point for the development of FAIRsFAIR's own competence framework. The FAIR Competence Framework for Higher Education (FAIR4HE) proposes core competences for FAIR data education that can be used by universities to develop teaching courses and training activities to integrate RDM and FAIR data-related skills in their curricula and programmes.[10] It does so by building on competences identified in the EDISON Data Science Framework (EDSF)[11] and complementing this study with a new job market analysis on data stewardship and related careers to address new needs and requirements created by the growing relevance of FAIR data in research activities.

This preparatory work set the base for the two final deliverables of WP7: the adoption handbook "How to be FAIR with your data – A teaching and training handbook for higher education institutions" and this good practice report. Both documents represent practical tools that will support higher education institutions in implementing RDM and FAIR data skills development and related materials in their curricula at the bachelor, master and doctoral levels.

The teaching and training handbook provides ready-to-use model lesson plans on a variety of Open Science topics, including FAIR data, Data Management Plans (DMPs), repositories, data creation and reuse. Furthermore, it offers FAIR competence profiles and learning outcomes for the bachelor, master and doctoral levels as well as information on course design and the implementation of the FAIR principles at the institutional level.[12]

This good practices report aims to complement the handbook, providing practical examples and recommendations on the best approaches to adopt to start embedding FAIR data education in university programmes and doctoral training. The objective of this report is also to provide inspiration to universities that want to offer more FAIR data-related training and are seeking guidance on possible steps to take to start or bring forward their development, addressing potential implementation challenges and providing strategies to ensure their sustainability.

The seven case studies presented in this report aim to provide such inspiration. They will do so by highlighting drivers and ambitions behind the decision to create new initiatives addressing FAIR data, emphasising steps required for their implementation as well as lessons learned and key findings from the experiences of higher education practitioners working in the field of

[9] Principe, P., Vieira, A., Stoy, L., Engelhardt, C., Saenen, B., Davidson, J., Whyte, A., Demchenko, Y., Herterich, P., Leenarts, E. (2020), "D7.2 Briefing on FAIR Competences and Synergies". Zenodo. Retrieved on 20 October 2021, from: https://doi.org/10.5281/zenodo.5361913.
[10] Demchenko, Y., Stoy, L., Engelhardt, C., Gaillard, V. (2021), "D7.3 FAIR Competence Framework for Higher Education (Data Stewardship Professional Competence Framework)". Zenodo. Retrieved on 20 October 2021, from: https://doi.org/10.5281/zenodo.5361917.
[11] More information on the EDISON Data Science Framework (EDSF) is available here: https://edison-project.eu/edison/edison-data-science-framework-edsf/. Retrieved on 13 December 2020.
[12] Engelhardt, C. et al. (2021), How to be FAIR with your Data: A teaching and training handbook for higher education institutions. Zenodo. Retrieved on 15 December 2021, from: https://doi.org/10.5281/zenodo.5665492

research data. An analysis of the approaches outlined in the case studies formed the basis for our recommendations targeted toward higher education institutions that are interested in developing more opportunities for FAIR data education at different levels. The specific experiences and lessons learned from the individual case studies are presented in chapter two of this report. This selection does not claim to be representative of the entire landscape of FAIR data education currently offered in European and international higher education institutions. Moreover, it is important to underline how the analysis and recommendations offered in this report were not deduced solely from the input offered by the case studies, but are rather the result of the different activities and studies conducted by the WP7 partners over the past three years. The analysis also benefited from the work of the European University Association (EUA) in contributing to and advocating for the development and implementation of FAIR research data management and data sharing practices in the higher education sector.[13] Input and comments from university leaders and practitioners were also collected during several events[14] organised by FAIRsFAIR's partners, where the first findings of this report and other works were presented and discussed with the broader higher education community.

1.2. FAIR data education: a changing policy landscape at the European, national and international levels

In recent years, discussions revolved around the need for a greater alignment with the FAIR data principles to support the transition to a more effective and sustainable management and sharing of research data. New initiatives have emerged at the European, national and international levels to support the acquisition and uptake of RDM and FAIR data skills and practices. These efforts are part of the broader policy context focused on achieving the mainstreaming of Open Science and on addressing new needs related to supporting the digital transition, including the development of data infrastructures that foster open sharing, as well as the growing demand for data-skilled professionals across EU Member States.[15]

At the European level, the development of the next generation of Open Science and data professionals is among the key priorities for the implementation of the European Open Science Cloud (EOSC), which will provide a shared ecosystem in which data can be accessed, shared and reused through the means of federating existing research data infrastructures.[16] Universities have a clear role to play in the roll-out of EOSC, as education institutions and training providers

[13] More information on the European University Association's activities and publications related to Open Science and research data is available here: https://eua.eu/issues/21:open-science.html#sec-research-data-and-eosc. Retrieved on 13 December 2021.

[14] More information is available on the FAIRsFAIR project website: https://www.fairsfair.eu/events/fairsfair-events Retrieved on 13 December 2021.

[15] European Commission (2020), "A European Strategy for Data". COM(2020)66 final. 19 February. Retrieved on 22 October 2021, from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0066&from=EN

[16] European Open Science Cloud. "Strategic Research and Innovation Agenda (SRIA) of the European Open Science Cloud (EOSC)". European Open Science Cloud, 15 February 2021. Retrieved on 20 October 2021, from: https://www.eosc.eu/sites/default/files/EOSC-SRIA-V1.0_15Feb2021.pdf

and as key contributors of research outputs. In addition, in recent years different EU-led initiatives were implemented to promote the uptake of RDM and FAIR data practices, and subsequently of their related skills, at the institutional level. Most notably, in the context of the Horizon Europe programme, the European Commission has mandated the development of outline plans for DMPs for all submitted project proposals to ensure that the work they fund leads to the availability of FAIR data. Moreover, Model Grant Agreements now explicitly require that data produced by EU-funded projects need to comply with the FAIR data principles.

At the national level, similar requirements have been put in place by national funding organisations. In addition, new policies were also implemented by several European countries to regulate and promote the transition to Open Science and its different areas. However, a recent report authored by the Landscape Working Group of the EOSC Executive Board highlighted a disparity between the number of countries that implemented policies regulating Open Access (61%) and policies on FAIR data (34%) in the surveyed EU Member States and Associated Countries.[17] Similar results were identified by the work of the EOSC Executive Board Skills and Training Working Group when analysing the landscape of national policies on digital skills. In particular, results showed how provisions related to FAIR data and data-intensive skills are fragmented or underdeveloped.[18] A parallel trend can be identified at the institutional level where the analysis provided in the EUA 2020 Open Science Survey[19] highlighted how issues of RDM, FAIR data and data sharing are gaining traction as strategic priorities in the institutional agendas of universities. However, the actual implementation of these practices is still lagging.[20] In this regard, the lack of data-related skills and training is seen as one of the main obstacles in closing this gap.

It should be highlighted that the needs and challenges presented above are not a specific European issue and are currently being discussed in different international and transnational fora, most notably the Research Data Alliance (RDA).[21] The outbreak of the COVID-19 pandemic also brought new impetus to put forward arguments in favour of data sharing practices and, subsequently, the need for research outputs to be findable, accessible, interoperable and reusable. In addition, the development of DMPs leading to the production of FAIR data have increasingly become a requirement among international funders as well as national funders from countries such as the United States and Canada.

To take stock of the developments happening at the international level, this collection will feature a case study from the University of Cape Town in South Africa. The example provided by the

[17] European Commission, Directorate General for Research and Innovation & EOSC Executive Board (2020), "Landscape of EOSC-Related Infrastructures and Initiatives. Report from the EOSC Executive Board Working Group (WG) Landscape". Publications Office. https://doi.org/10.2777/342650. Retrieved on 22 October 2021.
[18] European Commission, Directorate General for Research and Innovation & EOSC Executive Board (2020), "Digital Skills for FAIR and Open Science. Report from the EOSC Executive Board Skills and Training Working Group". Publications Office. https://doi.org/10.2777/59065. Retrieved on 22 October 2021.
[19] Morais et al. (2021).
[20] Ibid.
[21] https://www.rd-alliance.org/. Retrieved on 25 October 2021.

South African institution illustrates that the uptake of RDM and FAIR data skills and practices currently represents a broader global challenge and how the exchange of good practices between international partners can contribute in fostering cross-border collaboration in the field of managing research data.

As the analysis of the case studies will show, policy landscapes at the European, national and international levels play a crucial role in fostering the uptake of RDM and FAIR data skills and practices. First, policy initiatives can drive the emergence of new training activities, providing universities with the incentives and, in fewer cases, with the financial and capacity resources needed to proceed with their implementation. Second, existing or new training initiatives developed by practitioners at the institutional level can benefit from the presence of a broader policy framework, particularly in terms of ensuring their sustainability in the long term. Policy developments at the European and national levels are also instrumental to shape the internal policy debate in universities on FAIR research data, offering concrete arguments that practitioners can use to convince the institutional leadership on why and how new training activities should be funded and implemented.

To summarise, this report will present an up-to-date look at how FAIR data-related skills are currently being implemented by higher education institutions. To achieve this, a collection of seven case studies will be presented and analysed. The different cases introduce a diverse set of training and policy initiatives, which are all related to one common need: supporting the integration of FAIR data skills at the institutional level. The broad range of activities proposed in the collection shows how there are different approaches to tackle challenges and needs related to the implementation of RDM and FAIR data as established practices when producing and sharing research results. Findings and conclusions will highlight drivers, steps for implementation and the impact achieved by institutional initiatives and how those were influenced and, at the same time, feed into policy developments happening at the national, European and international levels.

1.3. Methodology and selection

The collection of good practices presented in this report represent different types of institutional initiatives from five European countries and one international case study. Initiatives ranged from cross-disciplinary teaching courses and training programmes to the establishment of new organisational units dedicated to RDM and FAIR data sharing practices. In addition, the collection includes an example of a funding scheme developed by a national rectors' conference. The target of these activities are master students and doctoral candidates. In some of the case studies, the initiatives presented are also open to students at the bachelor level, as well as members of academic and research staff. Where relevant, the report also highlights the presence of institutional policies aimed at supporting the uptake of those skills and practices.

Featured case studies are:

- **The Data Train programme**[22], a collaborative approach developed by the U Bremen Research Alliance (Germany) to produce theoretical and practical training for doctoral candidates, addressing the shortage of data-related skills.
- **The Research Data Management course**[23], a teaching course offered by the Doctoral School of Nova University Lisbon (Portugal) and developed by building staff capacity and leveraging senior management support.
- **The Center for Research Data Management and the Data Stewardship course**[24], an institutional department and a teaching course offered by TU Wien (Austria). The case study focuses on the importance of aligning bottom-up and top-down approaches and of leveraging institutional strategies to support the update of FAIR data-related practices and skills.
- An overview of **Research Data Management initiatives**[25] developed by Tampere University (Finland), including two teaching courses created as support actions for the implementation of the institutional Open Science Policy and Action Plan.
- **The Open Science programme**[26], a national-funded scheme targeting Swiss higher education institutions. The programme is offered by the Swiss national rectors' conference, swissuniversities (Switzerland) with the aim of promoting cross-institutional collaboration in the field of research data.
- **The Essentials on Research Data Management MOOC**[27], a Massive Open Online Course developed by the University of Minho (Portugal), which is the result of collaboration among national and institutional actors to support the uptake of RDM and FAIR data skills in the country.
- An overview of **Research Data Management initiatives**[28] developed by the University of Cape Town (South Africa), including support services and training sessions open to students, researchers and the university's staff to promote RDM and FAIR data skills and practices and support the implementation of the institutional policy.

[22] More information on the U Bremen Research Alliance's Data Train programme is available here: https://www.uni-bremen.de/en/research-alliance/research-data/data-train. Retrieved on 17 November 2021.
[23] More information on the Nova University Lisbon's Research Data Management course is available here: https://www.unl.pt/en/courses/study/escola-doutoral/research-data-management-course-9th-edition. Retrieved on 17 November 2021.
[24] More information on the TU Wien's Center for Research Data Management and Data Stewardship course is available here: https://www.tuwien.at/en/research/rti-support/research-data and https://tiss.tuwien.ac.at/course/courseDetails.xhtml?dswid=1165&dsrid=392&courseNr=194044. Retrieved on 17 November 2021.
[25] More information on Tampere University's Research Data Management activities is available here: https://research.tuni.fi/researchdata/. Retrieved on 17 November 2021.
[26] More information on swissuniversities' Open Science programme is available here: https://www.swissuniversities.ch/en/topics/digitalisation/open-science-2021-2024. Retrieved on 17 November 2021.
[27] More information on the University of Minho's Essentials on Research Data Management MOOC is available here (in Portuguese): https://www.nau.edu.pt/pt/curso/o-essencial-da-gestao-de-dados-de-investigacao/. Retrieved on 17 November 2021.
[28] More information on the University of Cape Town's Research Data Management activities is available here: http://www.digitalservices.lib.uct.ac.za/dls/services/rdm. Retrieved on 17 November 2021.

The inclusion of a wide diversity of activities in the case studies shows that there is not a "one size fits all" approach when it comes to integrating RDM and FAIR data skills at the institutional level. A broad range of initiatives can be put in place by universities wanting to foster the uptake of these skills, regardless of their different institutional strategies and capacity resources. A full overview of the case studies is presented in the table below.

Organiser	Name of initiative	Starting date	Type of initiative	Mode of delivery	Target group	Type of funding
U Bremen Research Alliance	Data Train programme	Since 2019	Training programme	Online	Doctoral candidates	Institutional and national funding
Nova Doctoral School (Nova University Lisbon)	Research Data Management course	Since 2015	Teaching course	Online (due to COVID-19)	Doctoral candidates	Institutional funding
TU Wien	Center for Research Data Management	Since 2018	Institutional unit dedicated to RDM	N/A	Whole university community	Institutional and national funding
	Data Stewardship course	Since 2018	Teaching course	Online (due to COVID-19)	Master students	Institutional funding
Tampere University	Managing Research Information course	Since 2017	Teaching course	Online (due to COVID-19)	Doctoral candidates	Institutional funding
	Research Data Management: Survey and Interview Data	Since 2020	Teaching course	Online (due to COVID-19)	Doctoral candidates	Institutional funding
swissuniversities	Open Science programme	2021/ 2024	National funding scheme	N/A	Swiss higher education institutions	National funding
University of Minho (UMinho)	Essentials on Research Data Management MOOC	First edition: 2019/ 2020 Second	Massive Open Online Course (MOOC)	Online	Doctoral candidates, researchers, research support staff	EU and national funding

		edition: 2020/ 2021				
University of Cape Town (UCT)	Training initiatives organised by the Digital Library Services (DLS) of the UCT Libraries	Since 2016	Training programmes	Online (due to COVID-19)	Whole university community	Institutional funding

Table 1: overview of case studies

Five of the seven case studies were based on good practice contributions collected during a series of university workshops organised by FAIRsFAIR to support higher education institutions in embedding FAIR competences in their curricular and research training programmes.

Originally, the workshops were intended to be physical events hosted by three project partners at their institution: the University of Minho (UMINHO) in Portugal, the University of Amsterdam (UvA) in the Netherlands and the University of Göttingen (UGOE) in Germany. However, the ongoing COVID-19 pandemic made it impossible to safely return to physical events in Europe. The workshops were instead organised as online events, with UMINHO[29], UvA[30] and UGOE[31] leading the events' development and organisation in cooperation with the European University Association (EUA). During the workshops, the exchange of views and experiences with participants was fostered by Q&A sessions and breakout discussions. The information gathered through these activities informed the analysis and reflections made in this report in addition to a series of interviews conducted to gain insights regarding the case studies.

Interviews were organised with representatives of each case study to discuss the use case being addressed by the initiative, details of the implementation and highlighting drivers and motives behind the decision to implement the good practice in the institutions. Questions revolved around four main areas, which also represent the pillars through which the findings of this report will be presented in chapter 3:

[29] More information on the workshop on "Integrating FAIR data competences in doctoral education programmes" is available here: https://www.fairsfair.eu/articles-publications/integrating-fair-data-competences-doctoral-education-programmes. Retrieved on 29 October 2021.
[30] More information on the workshop on "Training the trainers: Data Management and FAIR data principles in university curricula" is available here: https://www.fairsfair.eu/articles-publications/training-trainers-data-management-and-fair-data-principles-university. Retrieved on 29 October 2021.
[31] More information on the workshop on "Practical implementation of FAIR-related content in university curricula and teaching" is available here: https://www.fairsfair.eu/articles-publications/practical-implementation-fair-related-content-university-curricula-and. Retrieved on 29 October 2021.

- **Scope and objectives**, outlining key characteristics of the initiatives and the drivers behind the good practices as well as possible relations with institutional, national and European policy initiatives.
- **Implementation**, illustrating steps and potential challenges and barriers encountered in the development of the good practices.
- **Capacity**, highlighting organisational units and members of the staff involved at the institutional level, sources of funding and possible collaborations with other academic and private actors.
- **Impact**, describing processes used to evaluate the effectiveness of their initiatives, next steps for their further development and potential lessons learned.

2. Case studies

2.1. Data Train - U Bremen Research Alliance

Name of the initiative: Data Train - Training in Research Data Management and Data Science[32]

Use case: leveraging knowledge and resources through a regional-based collaboration to address shortage of data-related skills

Type of initiative: collaborative approach to developing and delivering interdisciplinary doctoral level training, including both theoretical lectures and practical workshops

Organiser of the initiative: U Bremen Research Alliance with financial support of the German Federal State of Bremen[33]

Data Train is a training programme at the doctoral level in research data management (RDM) and data science developed and delivered by the U Bremen Research Alliance with financial support of the German Federal State of Bremen. The U Bremen Research Alliance is a regional network that brings together the University of Bremen and twelve non-university research institutes in order to strengthen the cooperation in different research areas and scientific fields in the German Federal State of Bremen.

The collaboration of the cooperation network in developing and implementing Data Train shows how institutions can build on existing contacts between regional, national and private partners to develop a common strategy aimed at fostering RDM training and data science at the cross-institutional level. The experience of the programme also demonstrates how knowing the operational, legal, and cultural context in which a cross-institutional initiative needs to be implemented is crucial to create the right strategy to ensure its success and sustainability in the long term.

2.1.1. Scope and objectives

The Data Train programme aims to provide doctoral candidates with the basic skills needed to perform RDM resulting in Findable, Accessible, Interoperable and Reusable (FAIR) data and data science practices across their research activities.

The decision to develop the programme was driven by the partners of the U Bremen Research Alliance, who shared a consensus on the need to improve data-related skills at the doctoral level. Representatives of the programme highlighted how regular meetings among the leaders of the institutes within the network and representatives of the federal government was a success factor in the implementation of the strategy for the Data Train programme. The existence of the research alliance and of consolidated relations among its members and with external

[32] https://www.uni-bremen.de/en/research-alliance/research-data/data-train. Retrieved on 17 November 2021.
[33] https://www.uni-bremen.de/en/research-alliance/the-alliance. Retrieved on 18 November.

stakeholders was key in ensuring that all actors were engaged in the definition of the training programme and ready to weigh in on possible issues to address.

Policy developments at the national level supported these efforts. In particular, the emergence of the National Research Data Infrastructure (NFDI) provided a framework for establishing clear priorities and a course of action for the new training programme.

Securing the support from the leadership and leveraging on the existing research network in Bremen, as well as on established contacts with external partners, therefore proved to be instrumental to ensure the emergence, development and subsequent implementation of the Data Train programme.

2.1.2. Implementation

The Data Train programme offers a flexible and cross-disciplinary curriculum, with free lectures being classified according to the participants' level of prior knowledge ("Starter" and "Operator") and interests via two topics ("Data Stewardship" and "Data Science").

The programme was launched in December 2019, following an assessment phase, and is currently in its pilot stage. This process identified interdisciplinarity as a crucial aspect. The assessment of the different needs and challenges of the research community strengthened the initial idea that exploring the topic of RDM from a discipline-agnostic point of view could open the programme to doctoral candidates from different fields. For both, RDM and data science, cross-disciplinary basic knowledge is covered by the curriculum while high-level discipline-specific competences should be added by the respective scientific fields or training schemes of the discipline-specific NFDI consortia.

The Data Train programme specifically targets, and is designed for, doctoral candidates. While the U Bremen Research Alliance recognises the need to develop similar initiatives at the Bachelor and Master levels in the future, the network opted to start at the doctoral level and try to inspire the university's faculties in integrating data competences in their training offers, rather than imposing it in a top-down fashion.

2.1.3. Capacity

The Bremen alliance's extensive network of contacts and good relations with academic and private stakeholders were instrumental in finding both the financial and capacity resources needed to implement the programme.

Data Train is currently supported by a joint funding from the partners, including the University of Bremen and 12 research institutes, and the Federal State of Bremen. The programme is funded for a total period of 4 years.

More than 40 lecturers take part in the Data Train programme on a voluntary basis. Representatives of the programme highlighted that, during the development phase of the programme, the data professionals and senior scientists clearly shared the need for a training initiative of this kind in the assessment interviews. Many of them were therefore eager to become lecturers in the programme, bringing their specific knowledge and experience to the initiative.

Representatives of local businesses were also invited to take part in the lectures, bringing practical examples and experiences of how RDM and data science are performed in the context of the private sector. The presence of a consolidated network of relationships among institutional and business actors facilitated the involvement of businesses in the initiative.

2.1.4. Impact

The Data Train programme has brought together more than 150 participants during its pilot phase, which the interviewees indicated as a successful result for this online training initiative. In the evaluation surveys that are shared after each lecture, participants also highlighted the quality and usefulness of the programme. The successful start of Data Train allowed for discussions to begin with the leadership on the possibility to extend the initiative and integrate it in the University's and NFDI's training offer or as a stand-alone programme managed by the cooperation network U Bremen Research Alliance. The representatives are currently working on a "handbook" outlining the programme's concept and components (including the curriculum) to be shared with NFDI-training schemes.

COVID-19 has, perhaps surprisingly, played a role in the success of the Data Train programme. With the switch to online learning imposed by the health crisis, the programme decided to make use of the added capacity and open enrolment in the programme to doctoral candidates of institutions that were outside its network, as well as to other data professionals partly working in doctoral education. Based on this experience the U Bremen Research Alliance has decided to continue organising future training in a hybrid manner. Courses will continue online in order to remain available for a broader group, while a subgroup of the participants or other events such as in-house visits to non-academic actors will take place in person. According to representatives, this will allow the development of more networking opportunities for doctoral candidates and the reach of a larger pool of interested participants.

2.2. Research Data Management course - Nova University Lisbon

Name of the initiative: Research Data Management course[34]

Use case: building staff capacity and leveraging senior management support to foster the initiation of training courses and ensure their sustainability

Type of initiative: cross-disciplinary training course

Organiser of the initiative: Nova Doctoral School (Nova University Lisbon)[35]

The Doctoral School of Nova University Lisbon since 2015 offers a course in Research Data Management. This course was designed for doctoral candidates but allows other researchers, researcher managers, librarians, and research support staff from NOVA University to register. The initiative was taken by members of the University libraries, who saw an opportunity in national and European-level policy developments to propose the dissemination of good practices on research data management to better address the needs of the academic staff at their institution.

The development and implementation of this course show the ability of members of the staff to drive capacity building within their institution. Being close to the needs of doctoral candidates regarding RDM and FAIR data, practitioners such as academic librarians and members of the research support staff are shown to be able to act as drivers for change by sharing their knowledge and bringing new initiatives to the attention of the leadership. As such, this case also shows the importance of university leaders being attentive to the ideas emerging from within their institution and taking action to integrate them into broader institutional strategies. Finally, this case shows that such efforts can be even more effective when supported by a broader policy framework at the national or European level that offers an anchor point for bottom-up initiatives.

2.2.1. Scope and objectives

Nova's Doctoral School Research Data Management course aims to foster the ability of doctoral candidates to better manage their research data, following the FAIR principles and complying with the new requirements to access national and European funding.

The initiative to develop the course came from members of the university's library who, inspired by new policy developments happening at the European and national levels, wanted to address challenges and issues related to the lack of RDM and FAIR data-related skills and training at the institutional level. In this case, policy drivers for change were the Open Research Data Pilot of Horizon 2020 and the publication, in 2014, of two policies on Open Access and on data sharing and management promoted by the Portuguese national funding agency.[36]

[34] https://www.unl.pt/en/courses/study/escola-doutoral/research-data-management-course-9th-edition. Retrieved on 17 November 2021.
[35] https://www.unl.pt/en/study/doctoral-school/nova-doctoral-school. Retrieved on 18 November 2021.
[36] More information on both policies is available here: https://www.fct.pt/acessoaberto/index.phtml.en. Retrieved on 30 September 2021.

Interviewees highlighted how new European requirements and the guidelines and recommendations set by the national policies supported them in identifying which were the most urgent needs related to RDM and FAIR data in their institution. At the time, the concepts of data and FAIR data sharing were still new, and these practices were not yet common among doctoral candidates and other researchers. Targeted training activities were therefore needed to ensure that they would be able to comply with the new ambitions and demands coming from the national and European level.

2.2.2. Implementation

The Research Data Management course was launched in 2015. The course is organised twice per year and is now in its 9th edition. While the main target is doctoral candidates, the course is also open to other researchers, professors and the research support staff of Nova University Lisbon.

As mentioned, the initiative to develop the course came from members of the university's Libraries, who leveraged their existing contacts within the institution to, first, verify if they agreed on the need to create a RDM course, and second, to build a stable network to present this idea to the leaders of both the university and the Doctoral School.

Interviewees stressed how ensuring support from the leadership was a key step in bringing forward the development of the initiative. Meetings with the Vice-Rector of Nova University Lisbon and the Head of the Doctoral School were set to introduce the objectives of a potential new course and to persuade the leadership on the need to implement it. To achieve this aim, representatives of the Doctoral School highlighted how the new policy developments at the national and European level were used as key arguments to present a convincing case to the leadership and ensure receiving both the staff and financial resources needed to implement the course.

2.2.3. Capacity

The Research Data Management course is part of the training offer of the Nova Doctoral School. In terms of financial capacity, the main funding stream comes from the existing budget of the Nova University Lisbon, which is made available for activities organised within the Doctoral School.

In terms of staff capacity, lecturers of the course are the members of the university's Libraries who originally promoted the initiative and were then entrusted by the leadership to develop the content and deliver the course. In this regard, interviewees highlighted how the presence of an institutional leadership that was attentive to the voice and input coming from the staff was a key driver that motivated them not only to propose the idea but also to work on it to achieve the final result.

2.2.4. Impact

During its nine editions, the Research Data Management course received positive feedback from attendees, as shown by the results gathered through the evaluation surveys sent after each iteration of the course.

Across the years, the results of the course's evaluation surveys were a clear indication of the need for RDM training activities to take place in the Doctoral School. Responses received showed that awareness of how to manage research data in compliance with the FAIR principles was very low among participants. Supporting the emergence of RDM skills by enhancing training activities was therefore seen as a key action to raise awareness among doctoral candidates and the research support staff, as well as to fill potential gaps in the implementation of these practices at the institutional level.

At the same time, the experience of Nova Doctoral School shows how skills training is a necessary, but insufficient practice to promote RDM and FAIR data. Through informal exchanges with doctoral candidates from past editions, interviewees discovered that while doctoral candidates are well- intentioned to apply what they learned in the course, they still find different challenges and obstacles that prevent them from doing so. In this particular case, these challenges vary from lack of time and resources to inadequate support from doctoral supervisors.

Promoters of the initiatives are now working on the creation of a longer-term monitoring scheme to verify if and how participants have been putting into practice the skills and tools learned during the course in their daily research activities. Establishing a more structured feedback loop might help oversee if a real change happened in how research data are managed within the Doctoral School. Results of this effort will also provide support in calibrating the content of the course according to new needs and challenges that might emerge in the future.

2.3. Center for Research Data Management and Data Stewardship course - TU Wien

Name of the initiative: Center for Research Data Management and Data Stewardship course[37]

Use case: aligning bottom-up and top-down approaches to support the uptake of data-related practices and skills and leveraging institutional strategies

Type of initiative: institutional unit providing support on issues related to research data and teaching course on Data Stewardship, including both theoretical lectures and practical exercises provided by the Faculty of Informatics

Organiser of the initiative: TU Wien[38]

Since 2018, two separate initiatives have emerged at TU Wien with the shared goal of fostering the emergence of FAIR data-sharing practices among, respectively doctoral candidates and Master students. Firstly, the university created the Center for Research Data Management, which advises and provides training to all researchers and support staff working at the institution. Secondly, the development of a Data Science curriculum which includes the "Data Stewardship" course has been promoting the uptake of RDM and FAIR data-related skills and competences among students at the Master level.

While emerging independently from each other, the two initiatives are evolving into a comprehensive approach aimed at addressing RDM and FAIR data-related needs at different institutional levels, providing new training activities and integrating them into the broader institutional strategy. The experience of TU Wien also highlights the strategic importance of enhancing training provisions for RDM and FAIR data at the Master level, in terms of developing the next generation of data professionals. This is crucial in order to meet the growing demand for new data-skilled roles, which is now a reality not only for the for-profit sector but for the university sector itself.

2.3.1. Scope and objectives

The Center for Research Data Management is TU Wien's central contact point for all issues and matters related to the management and sharing of data produced by research activities. Another objective of the Center is the development of the university's data repository.

TU Wien also offers a Data Stewardship course for the students enrolled in the Master programme in Data Science, offered by the Faculty of Informatics. The course addresses different aspects of RDM, including the application of FAIR data principles and the creation of Data Management Plans (DMPs) and aligns with other courses, such as Experiment Design, Semantic Web Technologies, IT Security, etc., that deal with concepts relevant for/in data stewardship.

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[37] https://www.tuwien.at/en/research/rti-support/research-data and https://tiss.tuwien.ac.at/course/courseDetails.xhtml?dswid=1165&dsrid=392&courseNr=194044. Retrieved on 17 November 2021.
[38] https://www.tuwien.at/en/. Retrieved on 18 November 2021.

As we will see below, the data stewardship course initially developed independently from the Center. However both initiatives share the same goal: fostering the uptake of RDM and FAIR data skills and practices at the institutional level. Interviewees highlighted how decisions to develop the Center for Research Data Management and the Data Stewardship course were not taken in isolation, but were rather inspired by new policy developments and by a continuous dialogue with other universities from Austria and the rest of Europe. New funding requirements mandating DMPs and data sharing practices were particularly effective as top-down drivers for change. At the same time, professors, researchers and members of the research support staff were also involved in several European and national projects, which provided a platform for the partnering institutions to discuss policy and institutional needs related to research data, as well as exchange views and experiences on what needed to be done to make RDM and FAIR data a common practice across universities.

2.3.2. Implementation

The Center for Research Data Management and the Data Stewardship course were both created in 2018. As highlighted in the previous sections, both initiatives share the same goal and were inspired to some extent by the same (policy) developments. However, their genesis and implementation at TU Wien followed two different and independent paths.

The decision to create the Center was a direct result of the new institutional policy regulating RDM practices, which was developed and introduced by the university's Library in 2018. The Library's initiative received the support from the Rectorate of TU Wien, which decided to bring this effort even further by promoting the creation of a new institutional unit, entirely dedicated to research data. The implementation of the Center was therefore guided by a combination of bottom-up and top-down actions. While the Library started the conversion by promoting new policy developments within the institution, the leadership was ready to integrate them in the broader and longer-term strategy of the university.

The implementation of the Data Stewardship course occurred with a similar dynamic. The involvement of research staff in European and national projects aimed at promoting Open Science led to the recognition that more had to be done at the institutional level to enhance the training offer related to RDM. In this case, when the new Data Science curriculum was being designed, an old course on Digital Preservation was converted into the Data Stewardship course and integrated in the new curriculum.

2.3.3. Capacity

Both initiatives are funded by the institutional budget of TU Wien. In addition, some activities of the Center received seed-funding by the national project "FAIR Data Austria", promoted by the Austrian Ministry of Education, Science and Research.

Having a dedicated funding stream and a fixed team of experts was highlighted as a crucial element to ensure the development and success of the Center. When asked, interviewees from TU Wien highlighted how this was key in guaranteeing a continuity in both the financial and staff resources needed to develop a long-term strategy and the means to implement it. In particular, the dedicated funding allowed them to turn ideas into actions, moving from discussing perceived needs related to RDM, to actually put in place a strategy to address them. Interviewees also stressed how driving this change is a process that takes time and requires capacity. Investing in

the creation of a dedicated team of people whose main responsibility is following RDM issues and practices therefore proved to be a first step that brought substantial support to the implementation of FAIR data practices.

2.3.4 Impact

The Data Stewardship course has been gathering an average of 100 registered participants, although not all actively participate in the lectures. This is seen as a positive outcome by the university. Participation is not the only evaluation measure. taken into consideration to verify the impact of the activity and monitor if a real change is happening in how data are managed. Other indicators are being considered in the evaluation process to complement the participation rate and verify if the course had an impact in how data are managed by students. However the development of new indicators is still at an early stage.

In its first three years, the Center for Research Data Management has established itself as the university's central resource for all issues related to research data. Different factors are behind this success. Among them, interviewees from TU Wien stressed the importance of relying on a motivated team of experts eager to bring forward the institution's commitment to Open Science practices.

Ensuring that RDM and FAIR data become established practices requires the presence of a staff equipped with the right technical skills and competences. At the same time, interviewees highlighted how hiring people with such professional profiles can be a difficult task, a concern that is broadly shared within the higher education sector. In particular, the lack of a shared understanding of the new data professionals' competences and profiles and the growing competition coming from the for-profit sector were identified as two main challenges in the process of hiring data professionals with the skills needed to fill potential employment gaps. This challenge particularly applies to skills related to software development.

2.4. Research Data Management - Tampere University

Name of the initiative: Research Data Management at Tampere University[39]

Use case: building staff capacity and creating new training activities as support actions for the implementation of institutional policies

Type of initiative: institutional Open Science Policy and Open Science Action Plan and two training courses

Organiser of the initiative: Tampere University and its Doctoral School[40]

Tampere University implemented an Open Science Policy and Action Plan including an institutional approach to Research Data Management. Both documents were developed in 2018 during the creation of the university, following the merger of the University of Tampere and Tampere University of Technology. They provide a framework for doctoral candidates, other researchers and the research support staff on how data should be managed, curated and shared. Moreover, the Library of Tampere University developed two courses addressing RDM and FAIR data practices, which are delivered by the Doctoral School.

The development and implementation of the Open Science Policy and Action Plan were driven by staff members. Recognising the absence of a legal framework that could institutionalise RDM, they initiated the creation of the new policy documents, taking advantage of the opportunities offered by the merger in terms of redefining the objectives and strategy of the new institution. New training activities at the doctoral level also originated after the merger, with the establishment of the Research Data Services network, the university's central contact point for RDM coordinated by the Library. Both initiatives were introduced to support the research community in complying with the new mandates of the Open Science Policy.

2.4.1. Scope and objectives

The Open Science Policy and the Open Science Action Plan of Tampere University were created in 2018 during the merger of two institutions: the University of Tampere and the Tampere University of Technology. Tampere University of Applied Sciences also belongs to the Tampere Higher Education Community resulting from the merger.

The Open Science Policy states that all data produced by the new university's research activities need to be compliant with the FAIR principles and identifies all researchers as responsible for practicing good RDM. The Action Plan aims to turn the general guidelines of the Policy into concrete steps to follow, ensuring that all the members of the academic and research community are aware of their responsibilities regarding the good management of their research data. Among the key actions identified by the Action Plan is the integration of RDM and FAIR data teaching and training in the curricula of the university, from the bachelor to the doctoral level.

[39] https://research.tuni.fi/researchdata/. Retrieved on 17 November 2021.
[40] https://www.tuni.fi/en. Retrieved on 18 November 2021.

Both policy documents have the objective of institutionalising a FAIR-compliant management of research data in the university. Interviewees from Tampere University highlighted how RDM and FAIR data practices were already common before the merger, among the research support staff of the pre-existing universities. However, a new framework was needed to include Open Science as a priority of the new university and to provide a formalisation of these voluntary practices, ensuring that RDM and FAIR data would become the standard way of producing scientific knowledge.

Training activities have been implemented in support of the new policy framework to ensure that doctoral candidates and other researchers have the right skills and tools to comply with the mandate for FAIR research data set by Open Science Policy and Action Plan. The Doctoral School of Tampere University offers its doctoral candidates two courses that address, to different extent, RDM and FAIR data: Managing Research Information and Research Data Management: Survey and Interview Data.

2.4.2. Implementation

As mentioned in the previous section, the implementation of the Open Science Policy and the Action Plan took place during the creation of a new institution. Interviewees from Tampere University highlighted how the merger facilitated the development of the new policy framework, as it gave them the opportunity to bring emerging requirements for Open Science practices to the attention of the leadership during a broader process of rethinking the objectives and strategy of the new university.

Interviewees highlighted how ensuring the support of the leadership was key not only in terms of receiving the formal approval of the policy documents, but also to sustain the implementation of Open Science practices in the institution with a longer-term perspective. In particular, this was instrumental in providing a commonly agreed framework that would justify the need for future actions and activities related to research data to the eyes of the leadership.

The institutionalisation of FAIR research data practices is an ongoing process at Tampere University, which has recently moved to the higher institutional level. At the beginning of 2021, the university created a new Board for Research Data Management, chaired by the Vice President for Research. While still at an early stage, interviewees highlighted how the new Board will have the crucial role of identifying and setting the university's priorities in the field of research data, contributing to support the guidelines and objectives set by the Open Science Policy and Action Plan.

The implementation of the two RDM courses followed a different dynamic. While they share the same objectives, they have a different development history within the new institution. The Managing Research Information course built on a course that was already existing before the merger as part of the University of Tampere's training offer, dating back to 2017. The Research Data Management: Survey and Interview Data course was instead a direct result of the Open Science Policy and was implemented in 2020, after the merger was completed.

2.4.3. Capacity

Both courses are part of the training offer of the Doctoral School of Tampere University. In terms of financial capacity, the funding belongs to the existing university's budget, which is made available for activities organised within the Doctoral School.

While the coordination of the courses is a responsibility of the Doctoral School, the development of the content and their delivery are managed by the university's Library within its role in the Research Data Services. The Research Data Services are the Tampere University's central point for all issues and activities related to research data, aiming at coordinating tools and training in different phases of the research data lifecycle. The Services are coordinated by the Library, with the participation of the university's IT, research and legal services and the Finnish Social Science Data Archive.

2.4.4. Impact

The evaluation of the courses is coordinated by the Doctoral School, which collects feedback from participants and submits them to members of the Library who were responsible for the lectures. Over the years, the courses received good feedback and a participation rate deemed satisfactory by the university.

Interviewees from Tampere University highlighted that more can be done to broaden the impact of these activities. In this regard, they identified the voluntary nature of the courses as one of the biggest challenges in reaching more participants among the doctoral candidates, who should all be aware of how to practice good RDM in order to be able to comply with the mandates of the Open Science Policy and Action Plan. At the same time, the decision to integrate basic concepts related to RDM and FAIR data in the Doctoral School's mandatory course in Research Ethics and Integrity proved to be a strategic action in ensuring that all doctoral candidates are at least aware of these topics and the role they can play in their research activities.

Plans are being discussed at Tampere University to develop new training activities targeting students at the Bachelor and Master level. This is also one of the priorities identified in the Open Science Action Plan of the university. New developments are still at a very early stage, however, interviewees presented this as an example of the type of support that is granted by the policy documents, which are seen as an important leveraging tool for the Library when presenting their case to the leadership.

The decision to formalise the commitment to FAIR RDM at the higher level, through the establishment of the Board for Research Data Management is also a clear indicator of the impact that the implementation of the Open Science Policy and Action Plan had in influencing the strategic focus of the university towards research data.

2.5. Open Science programme - swissuniversities

Name of the initiative: Open Science programme[41]

Use case: promoting collaboration among higher education institutions in the field of research data through a national funded programme offered by a national rectors' conference

Type of initiative: national funding scheme

Organiser of the initiative: swissuniversities[42]

Swissuniversities developed the Open Science programme to support the implementation of national action plans on Open Access and Open Research Data. The programme encourages Swiss higher education institutions to collaborate with each other and submit project proposals addressing the objectives and action lines set by the national strategies.

The case study shows the role National Rectors' Conference can play in promoting collaboration among their members to advance the uptake of skills and practices in the fields of Open Science. Funding schemes like the Open Science programme are key to provide universities with resources, both in terms of staff and financial support. They also create an overarching policy framework to help universities further develop their own initiatives and ensure their sustainability. Fostering the collaboration among higher education institutions that have different levels of experience with RDM practices, training and infrastructures is also a good strategy to fill potential implementation and knowledge gaps across regions.

2.5.1. Scope and objectives

The Open Science programme is a national funding scheme for the period 2021-2024 developed by swissuniversities, the Swiss National Rectors' Conference, with the support of the Swiss State Secretariat for Education, Research and Innovation (SERI).

The programme aims to support the implementation of the national Strategy and Action Plan Open Access (2018-2024) and the national Strategy and Action Plan Open Research Data (2022-2024). To achieve this objective, the programme promotes the cooperation among Swiss higher education institutions, which are invited to submit project proposals that address the topics and action lines of the policy documents. These are identified in two calls for projects of the programme: Open Access (2021-2024) and Open Research Data (2022-2024).

The Open Science programme builds on a previous funding scheme developed by swissuniversities on Scientific Information, which was instrumental in supporting the emergence of new infrastructures, new publications and new training activities to facilitate the transition to Open Science at the institutional level. However, interviewees from swissuniversities highlighted how new actions needed to be taken in order to optimize the results achieved by different Swiss higher education institutions. The Open Science programme aims at promoting and supporting

[41] https://www.swissuniversities.ch/en/topics/digitalisation/open-science-2021-2024. Retrieved on 25 October 2021.
[42] https://www.swissuniversities.ch/en/?r=1&cHash=70419db05caeaba84d816a1097aa810c. Retrieved on 18 November 2021.

this coordination process, creating bridges and synergies nationally to optimize resources. One of the key objectives of this programme is to encourage universities to collaborate with each other, acting on their different strengths and complementary skills and resources to bring forward the objectives of the new national policies.

Interviewees underlined the crucial role of higher education institutions in achieving the objectives of the Open Science programme and the policies it supports. Both the Open Access and Open Research Data calls aim at coordinating and providing support to initiatives that are developed by universities. As such, institutional autonomy plays a key role in the design of this initiative. Universities are in charge of formulating their strategies, using the guidelines of the calls and the objectives of the national policies as a framework to support their implementation. While the Open Science programme aims to drive the cultural change towards Open Science at the institutional level, bottom-up and top-down dynamics based on specific action lines are at the core of this process.

2.5.2. Implementation

In January 2020, swissuniversities received the mandate from the SERI to develop the National Open Research Data Strategy and its Action plan, which would be supported by a new call for projects for the period 2022-2024.[43] While the national strategy was published in June 2021, the Action Plan and the call for projects on Open Research Data are currently being discussed and will be launched in late 2021 and early 2022. They will complement the Open Access Strategy and Action Plan and its relative call for Open Access projects, which was already launched in late 2020 following the decision, taken in close consultation with members of swissuniversities, to prioritise the Open Access pillar.

Interviewees from swissuniversities highlighted how the implementation of the Open Science programme benefited from the support of an advisory ecosystem operating at the national level. This included the SERI and swissuniversities' Open Science Delegation, whose members represent different Swiss higher education institutions. New Focus Groups on Open Research Data were also created to contribute to the development of the national strategy and action plan related to research data.

2.5.3. Capacity provided to member institutions

The Open Science programme receives funding from the State Secretariat for Training, Research and Innovation (SERI) of the Swiss Confederation. In terms of budget, the funding for the Open Access and Open Research Data calls amounts, respectively, to 11,8 million CHF and 32.48 million CHF.

The funding provided by the programme is an important support mechanism for Swiss higher education institutions to develop new initiatives in support of Open Access and FAIR data-sharing practices and exemplifies the strategic role that National Rectors' Conferences, such as swissuniversities, have in amplifying the capacity of their members to practice Open Science.

[43] The full text of the National Open Research Data Strategy is available here: https://www.swissuniversities.ch/fileadmin/swissuniversities/Dokumente/Hochschulpolitik/ORD/Swiss_National_ORD_Strategy_en.pdf. Retrieved on 25 October 2021.

The proposed programme is based on the Open Research Data (ORD) Strategy and action plan, which is the result of collaboration between Swiss higher education institutions and national actors in this field including the Swiss National Science Foundation[44], the ETH Domain[45] and the Swiss Academy of Sciences[46]. The collaboration with these key stakeholders is essential because of the very important role that each stakeholder plays in the development and promotion of research nationally.

To this end, the national ORD strategy foresees the creation of a Strategy Council, which will be responsible for developing a common vision for the future ORD landscape in Switzerland to ensure both the coherence and interoperability of all infrastructure and services, while supporting interfaces with other research areas. This new body will assume responsibility for initiating the development and communication of Swiss positions in international debates, while guaranteeing the autonomy of the higher education institutions it represents.

2.5.4. Impact

While the Open Science programme is in its early stages and has not been formally evaluated, interviewees shared reflections on the experience of swissuniversities in evaluating the impact of previous funding schemes in order to provide examples of how a national programme of this kind can be evaluated going beyond traditional indicators, such as the number of projects funded. In particular, they highlighted the importance of conducting a qualitative evaluation process, examining which projects became established services for the university community and how their activities are progressing after the end of the programme. This is instrumental not only in evaluating the impact of a programme, but also in setting new objectives and identifying further needs to address with future activities, as well as opportunities to enhance the long-term sustainability of the projects.

Different lessons learned were also identified by swissuniversities, corresponding to key aspects that contributed to the smooth development of the Open Science programme. The collaboration between European, national and institutional stakeholders showed the important role of establishing good communication among different actors and across different levels. This was crucial in terms of engaging all the partners who were involved in the process and ensuring the consensus needed to bring forward the implementation of the activities. The presence of a motivated team of experts within the staff of swissuniversities and reviewers within the reviewers' pool outside of swissuniversities were also key to find solutions and ideas to develop the programme. In particular, interviewees highlighted how experts with a diverse set of skills and backgrounds were needed to provide valuable expertise on complex challenges experienced by their member institutions with respect to the different action areas of the Open Access and Open Research Data calls. In addition, the Swiss Open Science programme follows an open review process[47], as defined in the UNESCO Open Science Recommendation[48]. This

[44] https://www.snf.ch/en/FKhU9kAtfXx7w9AI/page/home. Retrieved on 25 October 2021.
[45] https://www.ethrat.ch/en/eth-domain/overview. Retrieved on 25 October 2021.
[46] https://scnat.ch/en. Retrieved on 25 October 2021.
[47] More information about the open review process of the Open Science programme can be found here: https://www.swissuniversities.ch/en/topics/digitalisation/open-science/oa-call-for-projects/open-review-process. Retrieved on 25 October 2021.
[48] UNESCO (2021), "First draft of the UNESCO Recommendation on Open Science". Retrieved on 25 October from: https://unesdoc.unesco.org/ark:/48223/pf0000374837.

translates itself by the ability to access freely and openly the detailed evaluation of all projects received by the Open Science programme.

2.6. Research Data Management MOOC - University of Minho

Name of the initiative: Essential on Research Data Management MOOC[49]

Use case: collaboration among national and institution actors to support the uptake of RDM and FAIR data skills

Type of initiative: Massive Open Online Course (MOOC)

Organiser of the initiative: Lead by the University of Minho[50] and commissioned by the General Secretariat for Education and Science from the Portuguese Ministry of Science, Technology and Higher Education

The University of Minho Documentation and Libraries Service (UMinho) developed an Open Online Course (MOOC) in Research Data Management Massive in 2019 commissioned by the General Secretariat for Education and Science from the Portuguese Ministry of Science, Technology and Higher Education. The course is open to doctoral candidates and other researchers from all Portuguese higher education institutions who are interested in acquiring a basic understanding and knowledge of practices related to RDM and FAIR data.

The case study shows the added value and mutual benefits of national and institutional-level actors working together to promote and support the uptake of RDM and FAIR data skills. The initiative to create the MOOC came from the Ministry for Science, Technology and Higher Education, who via the General Secretariat for Education and Science collaborated with the University of Minho to develop the content and implement the course in a new online platform aimed at fostering digital skills in Portugal. From the university's perspective, the objectives identified for the MOOC were in line with its strategic focus on Open Science. UMinho was therefore ready to take on this mutually beneficial project and use its experience in Open Science, RDM and FAIR data practices to contribute to the creation and delivery of a nationally available course.

4.6.1 Scope and objectives

The Essentials on Research Data Management MOOC is a 30-hour online course with six modules aimed at training doctoral candidates in the fundamentals of RDM practices, including writing Data Management Plans (DMPs), applying the FAIR data principles, identifying the right tools and the legal issues involved in sharing research data. The course is made available to all Portuguese higher education institutions in the online platform "NAU".[51]

While developed by the University of Minho, the initiative to create the RDM MOOC came from the Secretariat of State of the Ministry of Science, Technology and Higher Education. Developing a MOOC focused on addressing RDM practices was seen as a way to feed into two different policy initiatives that the Ministry was working on at the time (2016-2018). First, the MOOC could provide support to the implementation at the institutional level of the objectives of

[49] https://www.nau.edu.pt/pt/curso/o-essencial-da-gestao-de-dados-de-investigacao/. Retrieved on 17 November 2021.
[50] https://www.uminho.pt/EN. Retrieved on 18 November 2021.
[51] The NAU platform is accessible here: https://www.nau.edu.pt/en/about/. Retrieved on 14 October 2021.

the emerging national Open Science Strategy. Second, the MOOC could be integrated within the broader national strategy in support of the uptake of digital skills. With regards to this second aspect, respondents from the University of Minho highlighted the importance of linking the promotion of RDM and FAIR data skills and practices with other priorities in the agenda of national governments. This can be instrumental not only in finding additional financial and capacity resources for teaching those skills, but also in identifying new motivations and drivers to support their implementation.

The University of Minho agreed to develop the content of the RDM MOOC, recognising the potential that this could have in addressing internal institutional priorities on promoting Open Science skills and practices and in contributing to the objectives of the national strategies. At the national level, UMinho was also actively engaged in the Working Group (WG) responsible for defining the roadmap of the National Open Science Policy and developing new opportunities for training in data-related skills was among the recommendations identified by the WG. In addition, respondents underlined that a third driver for their engagement in the RDM MOOC was to be identified with the decision of Portugal's major national funder, the Foundation for Science and Technology (FCT), to update its policy data sharing and management, recommending the implementation of new training activities related to research data at the institutional level.

2.6.2. Implementation

The first edition of the RDM MOOC was held between December 2019 and June 2020. A second edition followed between November 2020 and June 2021.

The Secretary of State for Science, Technology and Higher Education gave the first impetus for the creation of a MOOC dedicated to RDM and then involved the General Secretariat for Education and Science. In particular, the course was conceived to feed into the new NAU initiative, a national online platform collecting MOOCs on different areas aiming to promote digital development, digital inclusion and literacy, education and qualification of the Portuguese population.

The NAU platform is a service developed and managed by the FCCN Unit of the Foundation for Science and Technology that allows the creation of courses in MOOC format produced by recognized and relevant entities in society. The UMinho MOOC from the Secretary of State for Science, Technology and Higher Education was one of the first courses made available in the NAU platform.

2.6.3 Capacity

Funding for the development of the NAU platform, which hosts the RDM MOOC, came from the European Regional Development Fund 2014-2020 and the COMPETE 2020 Community Operational Programme, as part of the Portugal 2020 Framework. The NAU platform is also part of the INCoDe.2030 initiative, aimed at promoting the uptake of digital skills in Portugal.

Regarding the sustainability of the course, respondents from the University of Minho highlighted that the funding received was only to create the RDM MOOC for one edition. However, given the high attendance numbers and the impact that the course achieved among the Portuguese higher education community, a second edition was delivered at the end of 2020. Small updates

were applied to the first edition based on comments and feedback received, without additional costs needed.

Respondents are looking for ways to build on the results of the RDM MOOC and, recognising the strategic importance given to Open Science and digitalisation in the national agenda, they are confident that new opportunities for funding will arise to deliver a third edition of the MOOC or to integrate the course material in other training initiatives.

2.6.4 Impact

The RDM MOOC was among the most attended courses of the NAU platform, with almost 3500 registered participants across the first and second editions and over 1100 certificates issued to those who have completed all the 6 course modules. In the survey sent after the completion of the MOOC, the majority of participants evaluated the course as very or highly useful for their professional performance as researchers.

Reasons behind the broad reach of the course were identified by interviewees in the shared recognition across Portuguese higher education institutions of the strategic importance that new training activities have in fostering data-related skills. In recent years, universities have been putting in place new institutional strategies and plans to drive the transition towards Open Science. Ensuring that researchers and their support staff are equipped with the skills needed to take on these ambitions is therefore crucial to support the implementation of Open Science practices at the institutional level. Leaders from several Portuguese universities were therefore keen on promoting the RDM MOOC among their research staff.

Good results in the turnout and evaluation of the MOOC are not the only indicators taken in consideration to measure the impact of the course within the Portuguese higher education community. Respondents underlined how the course contributed to renew a debate at the national and institutional levels on the need for more training activities of this kind, with the Council of Rectors of Portuguese Universities (CRUP) proposing to re-establish a WG dedicated to Open Science. The RDM MOOC has also been discussed within the context of the Research Data Management Forum, where participants appreciated its role in preparing doctoral candidates to comply with funding requirements and new policies related to research data. At the same time, the need for discipline-specific training was identified as the next step to take towards a strategy that fully supports the uptake of RDM and FAIR data related skills at the doctoral level.

While appreciating the results reached by the course, respondents highlighted how the RDM MOOC should be considered only as a piece of a broader puzzle represented by the national strategy for Open Science. By providing training for RDM and FAIR data skills, the RDM MOOC is indeed an important component of the picture, but more elements need to be fostered at the institutional level to ensure the success of the strategy in the long term. In particular, training should be complemented with the right infrastructures to manage, store and share research data, as well as with institutional policies providing a framework for RDM and FAIR data skills and practices to emerge as the standard way of producing scientific knowledge.

2.7. Research Data Management - University of Cape Town

Name of the initiative: Research Data Management at University of Cape Town[52]

Use case: building staff capacity and creating new training activities and organisational units as support actions for the implementation of institutional policies

Type of initiative: support services and training sessions on RDM and FAIR data topics open to students, researchers and the university's staff

Organiser of the initiative: University of Cape Town (UCT)[53]

The University of Cape Town implemented a range of services and training opportunities to support the uptake of RDM and FAIR data skills and practices at the institutional level. These activities are targeting students at the master level, doctoral candidates, academic staff and other researchers as well as the non-academic staff of UCT and of other interested institutions.

The case study shows how needs and challenges related to the implementation of RDM and FAIR data practices are not limited to Europe but are a global issue. The experience of the University of Cape Town includes several commonalities with the lessons learned from the European case studies, such as the importance of national and institutional policies, training needs for RDM and FAIR data, and opportunities coming from the collaboration with partners at the regional, national and transnational levels. Dialogue and exchange of good practices with international partners, therefore, has the potential to broaden the discussion and foster cross-border collaboration in the field of managing research data.

2.7.1. Scope and objectives

The Digital Library Services (DLS) of the UCT Libraries is one of the university's departments responsible for supporting and fostering Open Science practices at the institutional level. The DLS inhabit this role as one of the stakeholders in the UCT eResearch landscape, providing a variety of services, systems and resources to ensure that good research data management is performed within the university's teaching, learning and research activities. This includes giving recurring training sessions on several RDM and FAIR data topics and ad hoc training activities and consultations on request by different university departments. Support is also given to researchers and their support staff in using dedicated UCT infrastructures, such as the data management planning platform and the institutional data repository. Training delivered by the DLS is not limited to UCT affiliates and is open to all interested individuals from other South African (and international) institutions.

Training activities are provided as support measures to ensure that students at the master level, doctoral candidates and other researchers and the university's staff can comply with the objectives set by the institutional policy on Research Data Management. In particular, the RDM policy aims to "ensure consistent research practice related to data management principles that

[52] http://www.digitalservices.lib.uct.ac.za/dls/services/rdm. Retrieved on 17 November 2021.
[53] https://www.uct.ac.za/. Retrieved on 18 November 2021.

support effective data sharing, including open access; and the need for data to be discoverable, accessible, reusable and interoperable to specific quality standards".[54]

Interviewees also highlighted how providing training activities to support the implementation of RDM and FAIR data practices and more broadly the transition to Open Science contribute to the broader UCT's strategic agenda. In particular, it is crucial to define a leadership role for the university in the changing landscape of research and higher education, supporting UCT's capacity to address new challenges and needs in the way research is produced, shared and managed in the long term.

Interactions with international partners located in both the African and European continent played a key role in highlighting the need for more training activities related to FAIR research data practices. Interviewees highlighted the importance of participating in transnational fora such as the 2018 SciDataCon conference in Botswana, which was a landmark event for promoting the creation of an African community in the field of research data. Other key opportunities for building the Research Data Services at DLS have been regular attendance at the International Digital Curation Conference (IDCC) as well as the CODATA-RDA Schools of Research Data Science. More recently, the UCT Libraries became a member of the Digital Preservation Coalition (DPC), which was welcomed by interviewees as a milestone achievement for the South African university in terms of building contacts and fostering the exchange of experiences with other institutions in the context of an established international community.

2.7.2 Implementation

The Digital Library Services of the UCT Libraries started delivering regular training activities on RDM and FAIR data in 2016. The implementation was the result of the commitment of the university and in particular of the Libraries to dedicate more attention and resources to issues related to research data. Over the past two years, a dedicated series on RDM practices was launched and during the pandemic period pivoted to online webinars.

The development of a draft policy regulating RDM practices in 2015 was UCT's first attempt to foster the emergence of data-related skills in the university. The final document was formally introduced in 2018. Interviewees underlined how the Policy was particularly effective in providing key arguments to the university leadership on why good RDM practices had to be fostered and which support measures were needed to support their implementation at the institutional level. As a result, more and more senior researchers, who also serve as academic staff, have had to engage with the implementation of this policy and have it trickled down to their students.

Interviewees identified another important step for the implementation of the RDM-related training in the recruitment of two Data Curators within the Digital Library Services department as of 2016, and a Digital Scholarship Specialist as of 2018. The presence of these staff members dedicated to working on RDM was crucial in terms of planning the development and implementation of new services. In 2016, a Data Managing Planning platform was introduced, followed by the institutional data repository in 2017. The creation of the two infrastructures

[54] The University of Cape Town Policy on Research Data Management is accessible here: https://www.uct.ac.za/sites/default/files/image_tool/images/328/about/policies/TGO_Policy_Research_Data_Management_2018.pdf. Retrieved on 15 October 2021.

highlighted the need to start helping students, researchers and their support staff understand why and how these tools should be used. To do so, new skills had to be developed and training activities implemented. Since then, further systems and services have been added by the DLS team for the digital preservation and online showcasing of digital data.

2.7.3. Capacity

All training activities organised by the Digital Library Services receive funding from the institutional budget of the University of Cape Town.

The Digital Library Services team plays a key role in providing training activities and services related to RDM, as part of the Libraries and its role within UCT eResearch Centre. As mentioned in the previous section, the presence of full-time experts whose work is dedicated to addressing RDM issues, challenges and practices has been instrumental in ensuring the development and the success of the activities put in place by the Digital Library Services.

2.7.4. Impact

Attendance in the Digital Library Services' training activities was deemed satisfactory by the department. Attendance rates also grew in the training held from March 2020, as a result of the health measures imposed by the COVID-19 pandemic and the switch to online learning which made the sessions more accessible. Interviewees highlighted how referring to the usage figures on relevant platforms, such as the DMPs platform and the data repository, can provide alternative indicators to measure the impact that the training is having on how RDM is performed within the institution.

While the work of the Digital Library Services gathered good results in the past years, interviewees from UCT underlined how ensuring that new scientific knowledge is produced in compliance with RDM and FAIR data practices is an ongoing process. Each year, new groups of students and researchers have to be trained, while the staff needs to keep pace with a field that is in continuous evolution. To support this process, the Digital Library Services department together with the whole staff working in the UCT Libraries need to find new opportunities for capacity building, sharing their experiences and skills to allow anyone within the university community to be designated and act as a Data Steward, as required. Furthermore, the work on building a growing community of Data Stewards (researchers, staff and postgraduate students, who can extend the reach of DLS and provide more discipline-specific practices) has also contributed to the impact. DLS also ensures that it itself practices good RDM by making all of the online training sessions openly accessible as recordings, slides and recently, transcripts.[55]

At the same time, the university community should not be left alone in this endeavour and top-down support should be provided to enhance and sustain the impact of institutional efforts in fostering RDM and FAIR data practices and skills. When asked about what types of support measures they would expect from the national level, interviewees underlined the need for South Africa to adopt an Open Science policy, which could offer a broader, more effective and sustainable national framework to support the activities happening in the various institutions, for example, consortial provision of shared, sovereign data storage. Interviewees also called for a more committed engagement of South Africa within the Research Data Alliance (RDA), hoping

[55] All DLS produced material is available through the Libraries' active RDM Open Science Framework project: https://osf.io/5avhm/. Retrieved on 20 October 2021.

for the country to become a south(ern) African node within the Alliance. Exchanges with the wider international community need to be fostered as each country can bring its own ideas, experiences and good practices in the field of research data, contributing to enrich the policy dialogue on how the university sector can support and advance the implementation of RDM and FAIR data skills and practices.

3. Main findings

3.1. Scope and objectives

This section highlights the key characteristics of the case studies and the external and internal drivers behind their development.

All case studies share the objective of enhancing the uptake of RDM and FAIR data-related skills at the institutional level. The good practices included in this report show how this aim can be reached through a diverse set of initiatives not only related to teaching these skills but also to supporting students, doctoral candidates and other researchers in utilising these skills. New teaching and training activities, the creation of institutional bodies dedicated to FAIR research data and national-funded schemes can all be instrumental in the ultimate goal of making FAIR data the standard way of producing and sharing scientific knowledge.

However, the efforts outlined above should be supported by national policies promoting Open Science and be well integrated in the institutional agendas of universities. Policy initiatives at the national level are instrumental in offering universities a framework that can provide capacity resources and sustain in the long term institutional-based initiatives aimed at teaching RDM and FAIR data skills. Similarly, regulatory and mandatory policies at institutional level provide the appropriate framework conditions for the organisation of support measures to address the lack of data-related skills among students, researchers and the university staff.

Across European higher education institutions, the provision of RDM-related teaching is currently strongest at the doctoral level, due to the fact that doctoral candidates are more research focused.[56] This is reflected in the selection of case studies in this report, where the target audience mainly includes doctoral candidates. Two exceptions are represented by the good practices coming from TU Wien and the University of Cape Town, which developed, respectively, a Data Stewardship course for master students and different training activities open to all students and researchers enrolled in the institution.

While doctoral candidates are seen as a “priority” category, being more engaged in research activities than bachelor and master students, all interviewees agreed on the need to expand their training initiatives to the other levels. Training activities addressing RDM and FAIR data skills are lacking at the bachelor and master levels.[57] The interviews showed that the challenges behind extending their good practices to the bachelor and master levels include the need to take into account needs and priorities of the different faculties and their specific disciplines. Moreover, adding new content to pre-existing courses might bring significant changes that ultimately require their re-accreditation. At the same time, data management and curation is increasingly becoming an important and useful skill to acquire for both the professional and personal development of students, regardless of their decision to continue their academic

[56] Stoy et al. (2020).
[57] Ibid.

careers and enter doctoral education. In this sense, initiatives such as the "Microlectures on Research Data Management" for bachelor students developed by the University of Twente in The Netherlands are especially welcome as they allow students to get acquainted with managing information and personal data in a responsible and ethical manner.[58]

Interdisciplinarity is also a common characteristic of the case studies. All teaching and training activities presented address RDM and FAIR data from a discipline-agnostic point of view, focusing on different practices and topics, such as the creation of Data Management Plans (DMPs), licensing, data repositories and interoperability. Interestingly, all interviewees provided the same reflection highlighting both positive and negative aspects behind the decision to pursue a cross-disciplinary approach. Benefits of interdisciplinarity include the opportunity to ensure that the initiatives can reach a wider pool of participants, meaning doctoral candidates and, where applicable, students from different disciplines and faculties. At the same time, interdisciplinarity has its limits. Acquiring the basic competences related to RDM and FAIR data is indeed useful in terms of getting doctoral candidates more familiar with these issues and aware of their benefits. However, this needs to be followed and complemented with discipline-specific training that can consolidate the skills acquired and deepen them with examples of practical application in the specific disciplinary fields. Interviewees from the U Bremen Research Alliance gave a clear example of the benefits and limitations of setting up interdisciplinary training programmes. In particular, they highlighted how the cross-disciplinary focus of their Data Train programme was instrumental in teaching basic knowledge on RDM and FAIR data and enhancing networking and exchange opportunities among doctoral candidates from different institutions and with various research backgrounds. At the same time, they called for the different research fields to build on the experience of the Data Train programme and start to address discipline-specific competences in their teaching and training schemes.

There is a wide range of drivers behind universities taking the initiative to develop and implement RDM and FAIR data skills training initiatives. According to our observations, these can be divided into "external" drivers, which are coming from initiatives developed at the European, national and regional levels, and "internal" drivers, which can instead be traced back to developments occurring within the institutions themselves.

3.1.1 External drivers for the development of FAIR data training

All case studies identified the changing policy landscape at the national and European levels as an important driver to start implementing new training activities for RDM and FAIR data. In particular, interviewees at the practitioner level highlighted how policy developments were key in presenting the institutional leadership with convincing arguments to start investing financial and capacity resources for the development of the initiatives. For example, the emergence of the National Research Data Infrastructure (NFDI) in Germany was described as an important

[58] Clare, C. (2021). "Microlectures on 'Research Data Management': the Bachelor's Edition". 4TU.ResearchData. Retrieved on 29 October 2021, from: https://community.data.4tu.nl/2021/09/10/microlectures-on-research-data-management-the-bachelors-edition/.

influence in providing a policy framework for the development of the U Bremen Research Alliance's Data Train programme.

Policy developments at the national, European and international levels can be used as arguments to persuade university leaders in investing resources to develop new teaching and training initiatives in support of FAIR data skills

In view of new requirements put in place by a growing number of funding organisations, universities also recognised that doctoral candidates needed to be equipped with the right set of skills in order to continue accessing European and national funding. At the same time, the creation of national policies and initiatives addressing and promoting Open Science and its related areas started offering a support framework for universities to both develop new training and to sustain existing activities. The link between national policies and institutional initiatives is clear in the case of the Research Data Management course delivered by the Doctoral School of Nova University Lisbon, which was subsequent to the publication of a policy on data sharing from the Portuguese national funder. A further example transcends this collection, coming from the University of Montpellier where the "Scientific Data Management" curriculum was created, following new national policies promoting digitalisation and Open Science[59].

A key finding from this collection is the role that national rectors' conferences can have in fostering the capacity of universities to meet the objectives of national strategies. As national representatives of higher education institutions, national rectors' conferences have a clear understanding of both the needs and capacity of their members and the policy developments occurring at the national level. Acting as a bridge between the institutional and national levels, they can therefore provide their members with the financial and capacity resources needed to develop new initiatives and activities aimed at addressing issues and priorities highlighted in the national policies. This was exemplified by the Open Science programme developed by swissuniversities, the Swiss national rectors' conference, which has successfully encouraged universities to collaborate with each other to initiate projects, through a national-funded call, that would ultimately help meeting the objectives of the national strategies on Open Access and Open Research Data.

National rectors' conferences can play a key role in supporting the uptake of FAIR data-related skills, acting as a bridge between the institutional and national levels and providing universities with the resources needed to develop new training and teaching initiatives.

[59] More information about the Scientific Data Management curriculum (Diplôme Universitaire "Gestion des données scientifiques") offered by the University of Montpellier is available here: https://sdm.edu.umontpellier.fr/. Retrieved on 2 November 2021.

3.1.2 Internal drivers for the development of FAIR data training

The initiatives presented in this report also show that members of staff often act as internal drivers for change to promote the development of new training activities at the institutional level. Several interviewees highlighted how the development of the initiatives drew on discussions among members of the staff, especially those working in university libraries. In particular, staff members became the promoters of new training activities to support a more mainstream implementation of good RDM practices. Ensuring that outcomes of the research process adhere to the FAIR principles is a shared responsibility that involves all actors of the university community and should not be confined to data practitioners, such as data stewards and data scientists. To achieve this vision, a wider uptake of RDM and FAIR data skills across bachelor, master and doctoral levels is needed. Examples of the role of the university staff as internal drivers for change are offered by four of the five case studies coming from higher education institutions, where practitioners had a key role in translating the perceived need for more RDM and FAIR data training into actionable plans to address it.

Ensuring that outcomes of the research process adhere to the FAIR principles is a shared responsibility, involving all actors of the university community. It should not be confined to data practitioners, such as data stewards and data scientists.

While external influences were important in providing a broader framework to which new and old initiatives could be anchored, they were effective because they complemented ambitions and agendas that were being implemented at the institutional level. The majority of interviewees highlighted how their good practices were developed as support measures to address the objectives and guidelines stated in institutional policies addressing Open Science and related areas. These policies not only recognised Open Science as a strategic priority but, in most of the analysed cases, they also specifically addressed FAIR RDM as the new norm to which institutional research activities should adhere. Students, doctoral candidates and other researchers, as well as the research support staff, have to be equipped with the skills and tools needed to be able to comply with the objectives set by the new policy documents. New training activities therefore had to be put in place. Clear examples of this dynamic came from Tampere University and the University of Cape Town, with interviewees mentioning how institutional policies regulating Open Science were instrumental in providing a policy framework, approved by the leadership, that would justify in the long term the need for new initiatives aimed at supporting the actual implementation of these practices at the institutional level.

National, European and international policies provide important frameworks for universities to promote new teaching and training initiatives, but they can only be effective if they meet institutional strategies seeking to promote and implement FAIR data practices at the institutional level.

3.2. Implementation

This section identifies the processes underlying the development and implementation of the good practices, looking at where in the institutions or organisations the initiatives were first conceived and the steps that were taken in order to implement them. Across the case studies, these steps for the implementation followed either a top-down or bottom-up dynamic or, more frequently, a combination of both. In this analysis, top-down change is characterised by actions and support coming from the leadership of the universities but also with strategies put in place by national bodies, such as national ministries or national rectors' conferences. Bottom-up dynamics are present when change originates at the practitioner level, with members of the university staff, in particular from the university libraries, being promoters of the new training initiatives and finding resources to put them in place.

What we saw in this analysis is that, behind the effective implementation of the initiatives, there is often a combination of top-down and bottom-up approaches. In some cases, top-down decisions might prevail on bottom-up actions, or vice versa. However, these dynamics often change over time, leaving space for more interplay and connections among the two approaches. For example, effective and sustainable change cannot happen without the commitment of practitioners to make RDM and FAIR data standard practices in their universities. At the same time, their efforts need to be integrated into a broader strategy, be it institutional, national or supranational, to find the support needed to be sustained in the long term.

Combining top-down and bottom-up approaches is instrumental to ensure the effectiveness and long-term sustainability of new teaching and training activities for FAIR data skills.

A key finding from this collection is the crucial role that universities, including both leaders and practitioners, play in fostering the uptake of data-related skills from the bottom-up, if we take into consideration European and national levels as top-down frameworks. In this respect, the university staff often had a key role in defining and promoting new training initiatives that reflected needs and challenges also identified in European and national discussions. Here, change started from informal discussion among members of the staff who, through their daily work in the management of data and their participation on European and national projects, were aware of needs related to RDM and FAIR data skills and practices. They could therefore define new plans and strategies to address these needs and bring them to the attention of their universities' leaders.

Top-down support interacting with the bottom-up dynamic can take two forms. First, support can come from European, national and regional policies offering guidelines and a framework for actions. For example, this is the case of policy initiatives that identify Open Science and its related areas as clear priorities, recommending all actors involved in the research process to adhere to new standards and, in some cases, mandating compliance with these practices by setting up requirements to follow in order to access European and national research funding. In this respect, the interviews showed how universities are often ready to follow national guidelines

because they are in line with strategies and objectives that were also set at the institutional level, and not just as a way to address requirements and expectations coming from the top. Second, university leadership can approve ideas and proposals coming from the bottom and find ways to integrate them into the broader institutional strategies. An example of the key role that can be played by university leaders in being ready to take on the initiatives coming from their staff and bring forward their scope and implementation is offered by the case study presented by TU Wien. Here, the initiative of members of the university library to develop a new institutional policy on RDM was not only approved by the leadership but also brought further with the decision to create a new institutional unit entirely dedicated to research data.

Case studies where the top-down dynamic was dominant are represented by initiatives and programmes that originated from the national level. However, even in these cases, universities played a distinctive role in ensuring their success from the bottom-up, bringing to the table their expertise and knowledge in the field. For example, the Open Science programme developed by swissuniversities aimed at fostering collaboration across higher education institutions by providing policy guidelines and financial resources. Building on their own capacity and benefiting from the support of the programme, universities could therefore actively contribute to the achievement of the objectives set by two new national policies on Open Access and Open Research Data. However, they were still autonomous in formulating their strategies and designing new projects to put in place against the framework offered by the programme. A similar dynamic can be seen in the implementation of the Research Data Management MOOC, an initiative originating from the Portuguese Ministry for Science, Technology and Higher Education but developed in close collaboration with the University of Minho. While the framework and objectives of the course were set by the Ministry, the university was then autonomous in defining the concept and the delivery of the course, building on its expertise and knowledge in the field of research data.

3.3. Capacity

This section investigates the capacity of the interviewed institutions and organisations to implement the initiative. Capacity is here understood as funding and staff resources required to deliver the planned activities.

In terms of funding, we asked where the support originated from and how sustainable it was in the long term. In the majority of the case studies coming from higher education institutions, the main funding stream came from the existing institutional budget, which was made available to the actors or institutional units developing the training initiative. While in this report we will explore the added value of sustainable funding being dedicated over a longer term, we should be clear that this cannot be assumed to be the default situation across Europe. With this finding in particular it should be pointed out explicitly that the majority of cases selected for this report are institutions with the means to develop and implement early initiatives, while elsewhere these means might be harder to come by. Courses on RDM-related topics offered by the Doctoral School of the Nova University Lisbon and Tampere University benefited from an institutional commitment to long-term funding. Funding also came from national ministries and national and

regional programmes that, in the two institutional cases where this happens, were complementing the institutional budget. This is the case of the Data Train programme, which is not only funded by the U Bremen Research Alliance and its members but is also supported by the Federal State of Bremen. Some of the activities put in place by the TU Wien's Center for Research Data Management also received funding from a national-led project aimed at fostering the emergence of FAIR data practices at the institutional level.

A key finding from this collection is the added value brought by a regular source of funding entirely dedicated to the ongoing delivery of the education and training initiatives. Case studies that could count on this type of consistent support registered benefits in terms of ensuring the continuity of their activities in the long term as well as achieving goals and milestones that transcended plans initially set. While not all higher education institutions might be able to create a funding stream solely for initiatives and activities in the field of research data, the experiences of several case studies show how even the investment of a limited amount of seed funding can then be scaled up and make the difference in the long term.

The creation of regular sources of funding dedicated to the development of the teaching and training initiatives contributes to ensure sustainability. Even the investment of a limited amount of seed funding can be scaled up and provide benefits in the long term.

Looking at who is involved in the development and roll-out of the training initiatives, the case studies present a broad diversity of actors who took part in their development, implementation, delivery and evaluation. We mentioned how members of the university staff and, in particular, of the university libraries, played a central role in promoting several of the good practices presented in this collection. This finding aligns with different studies that show how librarians and data practitioners are still the category most engaged with performing RDM and FAIR data.[60] Consequently, they are also more aware of skills and training needs of students and doctoral candidates, as well as of the staff itself. Librarians, data stewards, data scientists and other members of the research support staff can therefore be key actors in the definition of new opportunities for advancing FAIR data education through training activities and outreach initiatives that also address the low levels of awareness on needs and benefits related to RDM and FAIR data practices. At the same time, university leaders also play a crucial role in allowing for and fostering this capacity building potential of their staff. To be effectively implemented and sustained in the long term, the efforts of practitioners need to be endorsed and supported by the institutional leadership. In particular, leaders need to be open to the initiatives coming from the bottom and ready to establish a continuous dialogue with members of their staff, as a way to foster their ability to drive capacity building at the institutional level.

External partners and stakeholders can also play an important role in initiatives aimed at supporting the uptake of RDM and FAIR data skills, particularly in terms of bringing a diverse set of experiences and expertise to the table. For instance, local businesses can be involved in training initiatives, following the example of the U Bremen Research Alliance's Data Train programme, where entrepreneurs were invited in the lectures to present their point of view on

[60] Stoy et al. (2020) and Morais et al. (2021)

the relevance of good RDM in the private sector. At the same time, it is important to underline that, in the definition of potential partnership among institutional and for-profit actors, universities should strive for clear agreements to ensure that the collaboration proceeds without challenges and misunderstandings, as it was outlined in EUA's work on collaborative doctoral education.[61] Agreements of this kind notably help to establish a common vision, realistic expectations and mutual understanding and respect for each of the parties' goals and constraints. These are therefore key elements of a strategy aimed at putting in place a solid and trustful collaboration among academic and business actors.

Teaching and training initiatives for FAIR data skills can benefit from the involvement of business actors to highlight the relevance of good RDM beyond the field of academic research.

3.4. Impact

This section investigates the impact of the case studies in changing the culture and practices related to FAIR research data at their institutions and organisations. While this type of impact is difficult to quantify, we asked interviewees to highlight different factors that could provide an insight on how the case studies promoted the uptake of RDM and FAIR data-related skills and shaped the policy dialogue on Open Science at the institutional level. In particular, Interviewees were asked to highlight strategies behind the evaluation of the good practices, potential next steps for their further implementation and lessons learned from their experiences.

In terms of evaluation, most universities sent follow-up surveys to participants in order to collect their feedback on the teaching courses or training programmes. These surveys not only investigated the level of satisfaction with respect to the initiatives, but also asked about the relevance of the acquired competences in daily work of participants. For example, this was done through the survey sent by the Doctoral School of Nova University Lisbon. Across the years, results of these surveys showed how participants, in this case doctoral candidates and other researchers, positively welcomed the Research Data Management course, recognising how the knowledge acquired during the course would be useful for both their personal and professional development. Still, as it will be highlighted at the end of this section, a diverse set of challenges hinder them from actively putting their acquired knowledge into practice. Participation rates were also a recurring indicator of the impact of the good practices, even though none of the initiatives required mandatory participation. Many interviewees mentioned high participation rates as an indicator of the success of the initiatives in reaching out to students and doctoral candidates and contributing to raise awareness on issues related to RDM and FAIR data.

[61] Borrell-Damian, L., Morais, R., Smith, J.H. (2015) *Collaborative Doctoral Education in Europe: Research Partnerships and Employability for Researchers. Report on DOC-CAREERS II project*. European University Association, p. 8. Retrieved on 3 November 2021: https://eua.eu/downloads/publications/collaborative%20doctoral%20education%20in%20europe%20report%20on%20doc-careers%20ii%20project%20.pdf

With the switch to online learning imposed by the adoption of the new health measures in relation to COVID-19, attendance in several of the courses and training programmes was extended to participants that were not envisaged in the original target group, for example members of the research support staff, or participants who might not have been able to join the lectures if they had taken place in a physical setting. A surge in the attendance after the switch to online learning was registered in the courses organised by Tampere University, Nova University Lisbon and the University of Cape Town. In the case of the U Bremen Research Alliance's Data Train programme, COVID-19 played an even greater influence in the definition of good practice. Being implemented in the midst of the pandemic, the programme was directly launched with an online setting. This allowed the initiative to reach such a broad range of doctoral candidates and other researchers from different institutions, also going beyond the Federal State of Bremen, that its promoters are planning to organise future iteration of the programme in a hybrid setting.

A main finding related to the evaluation of the initiatives is that the measures presented in the above paragraph are not adequately sufficient to take a full stock of the impact and influence achieved by the good practices. This limitation was recognised by the several interviewees, who agreed on the need to go beyond these practices and establish a more structured evaluation and monitoring system. Institutions included in this collection are taking steps that go in this direction, however their development is still at an early stage. For example, the Doctoral School of Nova University Lisbon is currently working on establishing a longer-term feedback loop which could support them in overseeing if a real change happened in how doctoral candidates perform FAIR RDM but also in adapting the programme of their course to address emerging needs and challenges in the field of research data.

Different measures can be used to evaluate the impact of teaching and training initiatives for FAIR data skills. However, these need to go beyond traditional indicators, such as surveys and participation rates, in favour of a more structured evaluation and monitoring system that takes into account how the skills and tools learned influence the way university actors manage their data in their daily work.

In addition, alternative modes of evaluation can be offered by factors that are indirectly influenced by the participation of students, doctoral candidates and other researchers in the training courses. This is the case of TU Wien, where interviewees mentioned how looking at the variation in the number of master thesis submitted on topics related to RDM and data science can be a good indication of how well the Data Stewardship course was welcomed by the students, who are willing to deepen their knowledge and expertise on the topics. Another example is offered by the University of Minho's Research Data Management MOOC, whose impact in the Portuguese research data community was mentioned and recognised in different national fora. While both cases do not offer examples of formal evaluation processes, they present interesting patterns of how training initiatives of this kind can influence practices and ideas around FAIR data education, leading to a need for more responsible and effective monitoring systems to be developed at the institutional level.

Quantifying the impact of the good practices within the institutions is also necessary for planning new strategies and plans to expand their implementation. Interviewees highlighted how positive achievements are in fact leveraged to present the university leadership with good arguments on why additional resources should be put at the benefit of these initiatives. For example, librarians at Tampere University are advocating for new training activities to be organised for thesis supervisors and for master students after witnessing the positive impact and good results achieved by two doctoral teaching courses addressing RDM and FAIR data. Similarly, the success of the Data Train programme in engaging doctoral candidates across various disciplines and from different Federal States in Germany provided the U Bremen Research Alliance with strong arguments to ask for extending the initiatives or turn it into a stand-alone programme offered by the network. In terms of next steps, the interviewees also identified a different range of actions, including the development of new teaching and awareness raising initiatives for bachelor and master students, doctoral candidates and other researchers, the definition of targeted training dedicated to specific roles within the research support staff, opportunities to engage more lecturers in the courses and to foster the emergence of data stewardship communities at the institutional and national levels.

Against this diverse set of ambitions and goals, the discussion with the interviewees also highlighted how enhancing training opportunities for RDM and FAIR data skills is important, but not in itself sufficient. Participants of the training programmes across the case studies indicated they would be willing to start putting in practice what they learned in the training. However, interviewees underlined how these attempts are often confronted with different challenges, mainly related to the absence of a clear institutional framework that fosters and regulates practices related to research data. In particular, a key obstacle is represented by the lack of an incentives and rewards system that can encourage researchers to manage their data following the FAIR principles and, only where possible, to share and open up their research outcomes. Currently, RDM and FAIR data, together with other areas of Open Science, still rank low as indicators used to assess research careers.[62] This often means that researchers perceive recommendations and European and national requirements mandating their data to be FAIR as an extra burden on their shoulders, rather than a practice that contributes to promoting the integrity and visibility of the outcomes of their work.

Enhancing teaching and training opportunities for FAIR data skills is important, but not sufficient. Training should be complemented by the establishment of an institutional framework that supports the implementation of research data practices. An integral part of this framework should be the development of a clear system made of incentives and rewards for researchers to practice FAIR and, where possible, share their research data.

Training data-related skills is only one piece of a broader and more complex strategy aimed at ensuring that the FAIR data become a reality in how data are managed, stored and shared in

[62] Saenen, B., Morais, R., Gaillard, V., Borrell-Damián, L. (2020). Research Assessment in the Transition to Open Science. 2019 EUA Open Science and Access Survey Results. Retrieved on 8 November 2021, from: https://eua.eu/downloads/publications/research%20assessment%20in%20the%20transition%20to%20open%20science.pdf

universities. In particular, to be effective in the long term, training needs to be complemented with commitments to invest in the right institutional and shared infrastructures that allow researchers to manage and share their data. At the same, these efforts need to be integrated in a comprehensive policy framework at the institutional level that recognises the strategic importance of FAIR research data and incentivises and rewards their production and sharing.

A key finding from this collection is the recognition that FAIR research data is not an isolated issue but can and should be connected with other priorities in national and institutional agendas to find additional resources and possible funding. First, managing research outcomes in a way that allows for their reproducibility and sharing address the need to ensure the transparency and integrity of the research. In this sense, integrating concepts related to FAIR data in doctoral courses dedicated to research ethics and integrity can be instrumental in ensuring that doctoral candidates, as they begin their careers, are equipped with sufficient knowledge and skills related to the key role of RDM in supporting research integrity. A successful example of this is offered by the experience of Tampere University. Second, it should be highlighted how data-related competences are now part of the wider discussion around digitalisation and the need to equip future graduates, researchers and civil society as a whole with the skills needed to support the digital transition. Following the example of the University of Minho's Research Data Management MOOC, which was part of a nation-wide effort to support the uptake of digital skills, universities can therefore find synergies with complementary initiatives and priorities to find additional resources and support at the national level.

Producing and sharing data following the FAIR data principles is not an end in itself. FAIR data skills and practices can be connected with other priorities in national and institutional agendas, such as issues of research ethics and integrity and needs related to digitalisation. Finding these synergies can be instrumental in order to find additional resources and possible funding streams for the definition of new training and teaching activities.

4. Conclusions

This report presents a collection of good practices in integrating FAIR data education in university curricula at the different levels. Through the analysis of external and internal drivers, steps for the implementation, invested capacity and the impact reached by the initiatives, the collection provides universities with points of inspiration and practical examples of how fellow institutions and organisations in the higher education sector addressed the need for more RDM and FAIR data-related skills to be taught at the bachelor, master and doctoral levels.

We offer the following recommendations, which are based on the case studies presented in this collection and supported by the previous work of the FAIRsFAIR project in supporting the uptake of FAIR data skills at the institutional level.

4.1. Foster the engagement of research and support staff and build capacity across all institutional levels

Librarians and members of the research support staff continue to be the professional category that is most aware of issues related to RDM and FAIR data.[63] This allows them to have a clear overview of the needs, challenges and opportunities related to research data and often motivates them to bring forward plans and ambitions to foster a FAIR research culture in their institutions. Through their engagement in projects, working groups and organisations such as the Research Data Alliance, members of the university staff are also increasingly active at the national, European and international levels, where professionals engaged with data stewardship and data science can meet and exchange views, experiences and best practices.

University leaders should leverage the ability of these staff to drive capacity building within their institutions. While librarians and members of the research support staff might not have all the answers, they are indeed in close connection with the work of researchers and can be aware of training needs at the institutional level, as well as of domain-specific issues and challenges related to research data. Establishing a continuous dialogue between leaders and practitioners can therefore ensure that these needs and challenges are addressed in the definition of new institutional strategies and plans to support the integration of FAIR data skills in university curricula and in the implementation of good FAIR RDM practices across research activities at the institutional level.

At the same time, opportunities for capacity building should not be limited to data professionals. Building a critical mass and ensuring the widest uptake of FAIR data-related skills at the institutional level will foster the creation of a growing community of data stewards within universities. FAIR RDM should not be solely seen as the responsibility of individual institutional departments. Instead, it is the whole university community that should take ownership of the needs and responsibilities related to making research data FAIR. This will create the necessary conditions to allow all institutional actors to become data stewards and increasingly manage and

[63] Morais et al (2021).

curate their data through a more transparent and sustainable approach. Three actions can support universities in achieving this vision: creating policies, building infrastructures and fostering skills training.

4.2. Develop and connect policies, infrastructure and skills training to mutually reinforce each other

A comprehensive strategy aimed at turning the FAIR principles into reality should be based on three main pillars: training, infrastructures and policies.

Training is necessary to address the shortage of data-related skills that is prevalent across higher education institutions. Equipping students, researchers and the university staff with the skills needed to practice good FAIR RDM is essential to address new requirements coming from the European and national levels. Moreover, reinforcing FAIR data-related training will be instrumental in ensuring that the outcomes of the research process follow a set of guidelines that ensure their reproducibility and reuse, opening up the path for the transition to Open Science.

At the same time, efforts to enhance and foster opportunities for training will fall short if not coupled with a renewed commitment to invest in existing and new infrastructure for data storing and managing and to develop institutional policy that recognise the strategic importance of RDM and FAIR data practices and lay out steps and procedures for their implementation. Universities also need to focus on ensuring the presence of a staff equipped with the necessary technical skills and competences to practice FAIR. At the European level, different initiatives attempt to provide definitions and roles for data-related professionals.[64] While more work still needs to be done to reach shared and recognised professional profiles for data careers, universities can use such tools such as FAIRsFAIR's ACME-FAIR[65] framework to self-assess how they are enabling researchers, and the professional staff who support them, to put the FAIR data principles into practice and to identify potential skills gaps within both their research teams and the broader institutions.

Enhancing training opportunities, investing in new infrastructures and staff and developing institutional policies is instrumental in ensuring that initiatives in line with the case studies presented in this collection will not only be sustained in the long term but will also achieve a strong and clear impact in making the institutional research culture FAIRer.

[64] European Commission (2020), "Digital Skills for FAIR and Open Science. Report from the EOSC Executive Board Skills and Training Working Group". Retrieved on 22 October 2021, from: https://op.europa.eu/s/tqPy.
[65] Laura Molloy, Angus Whyte, Marjan Grootveld, Lennart Stoy, & Bregt Saenen. (2021). Professionalising Roles through Training, Mentoring, and Recognition: ACME-FAIR Issue#3 (Version 2). Zenodo. https://doi.org/10.5281/zenodo.5747043. Public feedback on this draft is welcomed.

4.3. Be aware of opportunities at the European and national levels and integrate them in institutional strategies

Managing, curating and storing research data following the FAIR data principles should increasingly become the norm for how new scientific knowledge is produced and shared. Higher education institutions have a crucial role in achieving this vision, ensuring that future graduates and researchers are equipped with the skills needed to integrate FAIR data practices in the production and reuse of scientific knowledge. To do so, universities are increasingly dedicating resources and capacities to provide their communities with more opportunities to acquire FAIR-data related skills, recognising the strategic importance that these practices have in their institutional agendas and in fostering a research process that is more transparent and sustainable.

While the mandate for the higher education sector is clear, universities should not be expected to work in isolation. This narrative should instead be guided by a system of responsibilities shared between institutions and actors at the European, national and international levels. Policy frameworks and guidelines need to be established in order to support, in the long term, efforts and commitments taken at the institutional level.

The emergence of a diverse constellation of policy initiatives aimed at fostering the transition towards Open Science comes in support of this objective. In particular, they offer universities with opportunities to implement their own strategies with respect to Open Science and its related areas, including research data. These can come in the form of financial and capacity resources, through national funding schemes, or, more straightforwardly, of a policy framework comprising clear objectives and action points to which initiatives born at the institutional level can be anchored to find long-term sustainability.

Against this background, university leaders need to be attentive to the potential offered by the changing policy landscape at the national and European levels. In particular, they should find ways to develop comprehensive institutional strategies that connect institutional needs with new developments and opportunities coming from outside the university level.

At the same time, opportunities for advancing the implementation of RDM and FAIR data practices through fostering their related skills do not only come from policy initiatives involving Open Science. Data-related skills are now an integral part of a broader policy dialogue, which includes supporting the digital transition and ensuring that the research process follows values of ethics and integrity. Universities should therefore find synergies with other priorities in the institutional and national agendas, which can be instrumental in securing additional resources and setting up new plans to bring forward the uptake of data-related skills and practices.