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MONITORING MODEL FOR OPEN SCIENCE AND RESEARCH – PRINCIPLES AND PRACTICES

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Monitoring model for open science and research – Principles and practices

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1. INTRODUCTION

Open science and research is a broad umbrella term for a movement that seeks to promote access to researched knowledge. Open science and research has become an internationally important movement for promoting science and research, as well as their impact on society.

According to the vision of the Open Science and Research Declaration[1], by 2025 at the latest, "Open science and research are integrated in researchers' everyday work and support not only the effectiveness of research outputs but also the quality of research. The Finnish research community is an international forerunner in open science and research."

In order to contribute strategically to the objectives of science and research, it is useful for the research community to be informed about the extent to which open science and research methods are applied in their own and other organisations' activities. The promotion of science and research and the achievement of the objectives set out in the Declaration on Open Science and Research and its supporting policies therefore require the monitoring of the development of open science and research on both the national and the organisational level.

There is a strong basis for monitoring open science and research in Finland. The Ministry of Education and Culture prepared the Open Science Maturity Evaluation in 2015–2019[2]. The aim of the maturity evaluation was to identify the how well universities, research institutes, university hospitals, research funders and other actors in the research community has advanced in open science and research. The evaluation was also designed to support their efforts in promoting open science and research by identifying strengths and weaknesses in promoting openness, and to identify key areas for development.

From 2020 onwards, the Ministry has expressed a wish that the Finnish research community continues to monitor open science and research as a joint task, as the maturity evaluation will no longer be carried out in the same manner as previously. In 2020, the National Steering Group for Open Science and Research[3] established a working group to develop a next generation model for monitoring open science and research in Finland. The out-

1 https://doi.org/10.23847/isbn.9789525995251.
2 https://avointiede.fi/en/policies/maturity-evaluation.
3 https://avointiede.fi/en/coordination/steering-group.

come of the efforts of the working group shall be presented here as a monitoring model consisting of the topics to be monitored, the indicators and their data sources. In addition to the working group, the expert members of Open Science and Research Coordination have participated in the development of the monitoring model through the co-development implemented in May 2021. The monitoring model was also open to nationwide comments during 27 September – 1 November 2021. 54 organisations provided comments on the monitoring model.

1.1 OBJECTIVES OF MONITORING

Monitoring is used to create an overview of the operating models and achievements of open science and research applied by the Finnish research community and its organisations. The monitoring framework is provided by the Open Science and Research Declaration and its supporting policies[4]. Monitoring focuses on assessing the achievement of the objectives set out in the declaration and its accompanying policies.

Monitoring of open science and research supports the core principles of responsible research, and is carried out in accordance with them. The relevant principles are:

- Freedom of research and higher education
- Responsible conduct of research
- Research ethics
- Responsible evaluation of researchers
- Transparency, integrity and fairness of the research culture
- Diversity of the research culture
- Good governance
- Good contract practice and responsible contract principles
- Aspiration for a high level of international scientific and artistic excellence.

The indicators of the monitoring model are based on the objectives set out in the Declaration for Open Science and Research and supporting policies. The decision as to what to monitor is important. Monitoring impacts how organisations prioritise organisational development work and practices around open science and research. Indicators for the monitoring of open science and research are based on key open science and research objectives widely discussed and endorsed by the Community through policy work.

4 https://avointiede.fi/en/policies/policies-open-science-and-research-finland.

1.2 BENEFITS OF MONITORING AND SUPPORT TO THE RESEARCH COMMUNITY

Appropriately designed monitoring supports actors in the research community and encourages the development of further openness in science and research. Monitoring also provides the research community with important information on the achievement of its strategic objectives.

Monitoring supports the Finnish research community in the following ways:

1. Monitoring provides an overview of the current state of progress in the Finnish research community, especially in relation to European benchmarks. National monitoring also provides national information required in various international comparisons for open science and research, particularly within Europe.
2. Organisations can use the information gained from the monitoring to support and benchmark the progress of their own activities. Monitoring thus supports organisational self-assessment and the development of open science and research.
3. Monitoring produces an overall assessment of open practices to organisations. These assessments are public. This allows an organisation to compare its own development with other comparable organisations. The aim of monitoring is not in itself to compare organisations, as structural issues (such as operating environment, type of organisation, size or field of research) have an impact on research activities and adopted open science and research approaches.
4. The results of the monitoring can be used in the marketing of Finnish research organisations internationally.
5. Monitoring is not designed to be used in the national university funding model by the Ministry of Education and Culture for higher education and other ministries for research institutes. On the other hand, research organisations have the possibility to choose open science and research indicators in their bilateral negotiations with the ministry that is funding them. Monitoring does not thus restrict institutional autonomy or provide top-down guidance.
6. Monitoring supports the development of national open science and research services, helping to identify the areas of open science and research where development is of greatest benefit to the research community. As monitoring makes use of national databases, this will also support their development and utilisation.

1.3 MONITORING FOCUS

Monitoring is intended to observe the state of national open science and research and to provide organisations with a tool for self-assessment. Due to the diversity of research practices, monitoring is carried out at a general level. This monitoring model is targeted at the organisational level and it is not designed to evaluate open science and research practices of individual researchers, research groups or fields. Organisation-level monitoring provides an opportunity to consider the diversity of organisations and disciplines.

Monitoring focuses on the Finnish research community as a whole, i.e., those organisations that produce, publish and finance research, as well as those that maintain research services and infrastructures.[5] The monitoring model is developed in stages. In 2022, monitoring will focus on research organisations (universities and research institutes). The monitoring of other organisations will begin at the earliest in 2024.

Monitoring of the development of national open science services will be carried out as part of the annual European monitoring by EOSC. The Working Group on Open Science Architecture, which started in autumn 2021, may also produce a proposal for monitoring national services. The compatibility of the organisations and national services and a clear distribution of responsibilities between organisational and national services is a key to the development of open science. The monitoring model provides one element for the strategic development of both national and organisation-provided open science and research services.

Since organisations have different characteristics, not all monitoring elements and their indicators are suitable for all organisations in the same way. Monitoring of research publications, for example, has different meanings for universities, research institutes and universities of applied sciences, as well as in different disciplines.

The National Open Science and Research Policies are the basis for monitoring. The policies are in turn based on the Declaration for Open Science and Research, which has been signed by all Finnish research performing organisations. For some of the monitoring indicators (e.g., scholarly journals, educational resources, research data), a national policy (component) is already in place. When a policy exists, the definitions, tools and indicators used in the monitoring are aligned with the principles and objectives defined in the policy.

5 More detailed definition of domestic research community: Open Science and Research Declaration, p. 5, DOI https://doi.org/10.23847/isbn.9789525995251.

For some of the targets, the policies are still in progress and therefore monitoring is either based on draft policies or delayed. The monitoring model also presents planned indicators for monitoring in 2024; these will be confirmed when all policy work is completed by spring 2023 at the latest.

1.4 STRUCTURE OF THE MONITORING

In establishing the structure of the monitoring model, the working group has sought a balance between the ability of the selected indicators to reflect the level of achievement of the objectives and their impact on practices and organisational practices. The purpose of monitoring is to promote open science and research operating practices. In order to achieve a balanced picture, both quantitative and qualitative indicators are used as data sources.

The possible undesirable effects of monitoring have also been considered and efforts have been made to minimise them in the selection of indicators. In all monitoring, the challenge is that the indicators morph into absolute objectives that change the way the Community operates. Excessively heavy indicators can also cement practices that would be important to change as the environment changes. On the other hand, constantly changing indicators can produce unpredictable and impulsive developments and activities. These considerations have been taken into account by selecting indicators as a direct measure of the community's own objectives and by developing a structure in which some questions are permanent and some are reviewed and, if necessary, modified in the light of development in open science and research.

In order to make monitoring cost-effective, the monitoring model has been developed maximising the use of existing and comparable data. Ne data sources are being developed and monitoring will make increasing use of them in the coming years. The most important data source is the information collected directly from organisations in the research.fi portal. The use of common databases in monitoring will also support their development.

The monitoring model focuses on indicators that can be developed and used nationally. In this way, it is possible to produce high-quality and balanced information about the Finnish research community. International indicators can be used for monitoring as they evolve and are able to enrich Finnish indicators.

In addition to the quantitative monitoring of the research.fi portal, a qualitative open science and research survey is carried out every two years. This applies especially to the monitoring of the development of services, policy documents, research assessment and culture of open scholarship.

The monitoring model makes maximal use of existing indicators, but also proposes the development of new monitoring tools and data sources. The monitoring of open science and research will be developed in other countries at the same time as the Finnish model. International open science monitoring indicators are being widely developed, particularly in Europe. The monitoring model considers international development. In developing the next steps of the monitoring model, it is important to consider international developments of open science and research in general, and the development of the European Research Area (ERA) in particular, as well as the European monitoring and evaluation models that will emerge with Horizon Europe and the European Open Science Cloud (EOSC). Monitoring of European open science is likely to be carried out annually. This also contributes to the structure of domestic monitoring and the need for monitoring at two-year intervals at the minimum.

In the National Open Science and Research Coordination[6], open science and research are divided into four areas:

- Culture for open scholarship
- Open access to research data and methods
- Open access to research publications
- Open education and educational resources.

Indicators from all these areas will be attached to the monitoring model. Until now, the focus of open science and research monitoring has been on free access for the readers of digital research publications, both in Finland and internationally. A wide range of indicators has been also developed and adopted to monitor publications in Finland. Less domestic and international experience has been gained from monitoring other areas for open science and research. Thus, the development of a monitoring model in these areas is essential in order to obtain an overview on the development of open science and research.

Monitoring is often backwards looking. This monitoring model, too, provides a comprehensive assessment of what has been achieved. However, open science and research develops rapidly and monitoring should also encourage organisations to look ahead and experiment with new approaches to open science and research. In assessing these, a qualitative questionnaire is of paramount importance.

The implementation of the monitoring model for open science and research will take place in stages. The monitoring model will evolve as experience is accrued. The opportunities for monitoring will evolve as open science and research practices become

6 https://avointiede.fi/en/coordination.

more commonplace. Today, many of the areas identified as important for the monitoring work are still underdeveloped or only have incomplete indicators and are therefore not included in the first round of monitoring.

In the monitoring model, the future directions of monitoring are described separately for each component for 2022, 2024 and more generally as future trends.

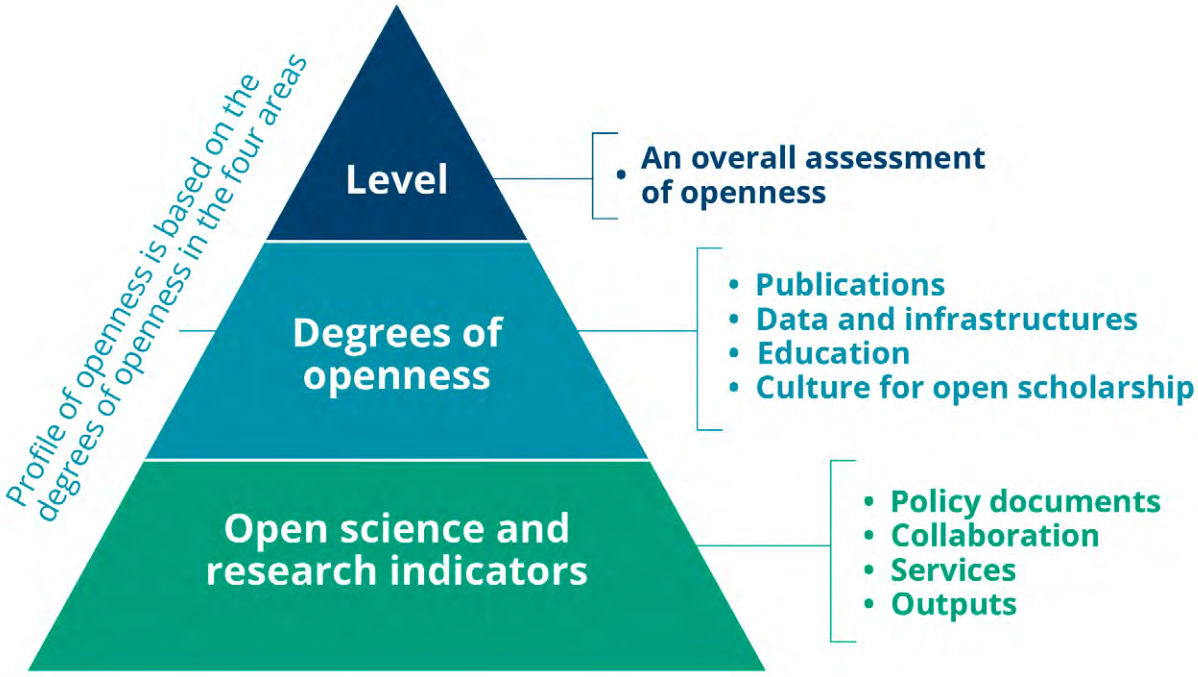
Monitoring for 2022 will be light and largely based on existing and known indicators and the needs of European monitoring. Monitoring in 2024 will be significantly broader. Introducing the indicators for it is a key task of Open Science and Research (OScaR) coordination during 2022. The entire research community will be invited to participate in the pilot project. In spring 2023, the National Steering Group for Open Science and Research will decide on the addition of new indicators to be implemented in 2024.

1.5 RESULT OF THE MONITORING

Monitoring indicators are used to define organisations' open science and research profiles and the level of open science and research. Limited indicators will be used in 2022. For the monitoring rounds in 2024, they will be increased to cover all aspects. The scoring principles are transparent and available to everyone.

The final model for the indicators will consist of the following elements:

- Organisation's level of openness – an overall assessment of openness based on the organisation's open science and research profile
- Organisational open science and research profile – a set of organisational degrees of openness calculated on the basis of open science and research indicators in the following areas:
    - Culture for open scholarship
    - Data and Infrastructures
    - Publications
    - Education
- Open science and research indicators – defined for each area according to the following ways of promoting openness:
    - Policy documents
    - Services
    - Collaboration
    - Outputs.



Monitoring indicators generate scores. Scoring is defined separately for each indicator. Some indicators do not apply to all types of organisations (e.g., those related to open education do not apply to research institutes). For some indicators, the scoring may be proportional to the size of the organisation in such a way that it is easier for a smaller organisation to achieve the maximum score for an indicator.

The monitoring examines the development of open science and research practices in the organisation from the perspective of different areas (publishing, data and infrastructure, education and culture for open scholarship) and ways of promoting them (policy documents, services, outputs and cooperation). In this way, it will be possible to examine the areas and practices and the links between them when examining the results of monitoring. In the monitoring for 2022, only a part of these are taken into account, as indicated in the table below. The aim for monitoring in 2024 is to monitor all these aspects.

	Policy documents	Services	Collaboration	Outputs
Publications	2022	2022	2024	2022
Data and infrastructures	2022	2022	2024	2024
Education	2022	2022	2024	2022
Culture for open scholarship	2022	2022	2024	2024

Points are accrued from each indicator. The points are either 'base points' or 'additional points'. The base points cover practices that are central to the implementation of the guidelines for all organisations. The additional points are for practices that are still new, evolving or produce added value.

Sum of the points defines the degree of openness of the organisation for each area. The degree of openness (1–5) of an area for each organisation is determined by the percentage share of maximum number of base scores on one hand, and of maximum number of total points on the other. The percentage-based approach makes it possible to add new indicators to the monitoring process in the future, making it scalable to the development of open science and research.

Since the purpose of monitoring is to promote open science and research models and because the monitoring model is not intended to be used as part of the funding model, scoring is not structured in such a way that the current condition would produce the highest degree of openness in the monitoring model.

Degrees to be defined for each area and percentages required:

Degree	Percentage
Degree 5	90% of the base points and at least 70% of the total points
Degree 4	80% of the base points and at least 60% of the total points
Degree 3	at least 60% of the base points and at least 50% of the total points
Degree 2	at least 40% of the base points
Degree 1	at least 20% of the base points

The degree of openness in the different areas will form the organisations' profile of openness. The profile demonstrates the degree of openness of an organisation in different areas (publications, data and infrastructure, education and culture of open scholarship) and, if necessary, the degree of openness can also be examined from the perspective of practices (policy documents, services, cooperation and outputs).

The profile is also used to assess an organisation's overall level of openness. In addition to the baseline, there are five levels of openness. The levels are defined in such a way that the next level requires either a one-step increase in two areas or a two-step increase in one area (i.e., an overall increase of a half-step in all areas). In addition, rising to higher overall levels requires that all areas of the profile improve to some degree.

- **Openness level 5:** The average degree of the profile's areas is 3.5. All areas reach at least degree 3.
- **Openness level 4:** The average degree of the profile's areas is 3. All areas reach at least degree 2.

- **Openness level 3:** The average degree of the profile's areas is 2.5. All areas reach at least degree 2.
- **Openness level 2:** The average degree of the profile's areas is 2. At least two areas achieve degree 2.
- **Openness level 1:** The average degree of the profile's areas is 1.5.

1.6 MONITORING IN PRACTICE

Monitoring is based on the data collected from the research.fi portal and through surveys. Monitoring will be carried out every two years. Organisational openness levels are also determined every two years.

Monitoring will be carried out during the monitoring years as follows:

1. A survey is carried out in May.
2. Data from the research.fi portal is retrieved in June (previous year's data).
3. The results of the monitoring, including the monitoring profiles and levels, will be published in October.
4. The National Steering Group for Open Science and Research will decide on possible changes to the indicators.
5. The indicators for the next monitoring cycle will be published in December, 18 months before the monitoring cycle is carried out. However, the monitoring indicators for 2024 will, exceptionally, be confirmed in spring 2023.

Monitoring requires resources from the research community. Monitoring will be carried out by the Secretariat of Open Science and Research (OScaR). Resources are also required in the research community organisations to build up data sources and to respond to the survey.

The Secretariat for Open Science and Research is responsible for communicating the results of the monitoring.

The results of the monitoring are published in research.fi and the survey results are stored for public open access. The first year of monitoring is 2022.

1.7 KEY DATA SOURCES

The aggregate data source is the **research database** of the Ministry of Education and Culture, the data of which is available on the research.fi website. The service is provided by CSC. The data in the research database is sourced from the VIRTA publication information service, national Fairdata services, as well as research organisations and funders.

The research.fi service provides information on publications, research data, projects, infrastructures and organisations. Functionalities will be developed for the research database to collect qualitative information about a researcher's expertise and activities. In the future, it will also be possible to consider including this information in the monitoring. Key information on open science and research is compiled on the website.

The **VIRTA publication information service (in Finnish)**[7] is a service purchased from CSC by the Ministry of Education and Culture, which compiles information on publications from all Finnish universities, universities of applied sciences, research institutes and university hospitals, thus providing up-to-date comparative information on their publication activities and open access to publications. The publication data collected in the service can be utilised in various systems and services. VIRTA is complemented by the **Jufo portal**[8], which provides information on the openness of domestic and foreign publishing channels and the parallel repository policy.

Fairdata services[9] are a service entity for managing research data produced in Finland. Fairdata's Metax metadata resource[10] contains metadata from Finnish research data, including their openness. Metax collects metadata from reliable sources, such

7 https://wiki.eduuni.fi/display/cscvirtajtp/VIRTA-julkaisutietopalvelu.
8 https://jfp.csc.fi/en/web/haku/.
9 https://www.fairdata.fi/en/.
10 https://www.fairdata.fi/en/metax/.

as the universities and research institutes' own systems. The first data sources imported into Metax have been the Finnish Social Science Data Archive (FSD), the Language Bank of Finland, Finnish Environment Institute and the University of Jyväskylä. In addition, Metax contains the metadata of the data contained in Fairdata services, which is published with the Qvain tool. Metadata regarding individual data can be stored via Fairdata's Qvain service. All research organisations have the opportunity to provide metadata of their data to Metax through the interface provided by Metax. The information contained in Metax is published both in Etsin – Research Dataset Finder and on research.fi website.

It is also possible to store metadata of research data in international data repositories, but monitoring them and the data stored in them is not realistic through Metax, at least for the time being, due to the large number of repositories and the diversity of the interfaces.

The **Library of Open Educational Resources** (**aoe.fi/en**) is a service of the Ministry of Education and Culture and the Finnish National Board of Education, which collects open educational resources at all levels of education. Open educational resources can be shared and used in the service. CSC is responsible for service maintenance and development coordination.

Evolution of information resources. Some of the information resources in the monitoring effort are new and the information contained in them does not provide comprehensive information on the state of openness in the Finnish research community. Monitoring and the collection and development of information resources therefore go hand in hand, which also improves the coverage of the information contained in the resources. Monitoring based on domestic information resources is being prepared in advance, so that organisations have the opportunity to contribute to the information contained in the assets.

The knowledge base of the monitoring effort will be expanded on the basis of qualitative surveys. The **survey** covers indicators that cannot be sourced directly from the research database. These include, in particular, monitoring the development of services and incentives, as well as organisation-specific documents guiding open science and research. The survey is carried out every two years as part of the monitoring of open science and research.

In 2022, the survey will play an important role. With the development of the information assets, the role of the survey will be reduced as soon as the monitoring effort in 2024. This model sets targets for data from the research database in 2024.

2. MONITORING INDICATORS

2.1 ORGANISATIONAL OPEN SCIENCE AND RESEARCH STEERING MECHANISMS/DOCUMENTS

The national open science and research policies provide top-level objectives for different open science and research areas. Achieving these objectives requires more specific goals and measures at the organisational level.

These governance mechanisms and their documentation are part of the monitoring of open science and research. This reflects European level as well. Monitoring of the steering mechanisms and documents of open science and research provides an overview of an organisation's overall orientation towards promoting open science and research and enables the preparation of a national overall assessment as part of European monitoring without additional surveys for organisations.

The maturity evaluation prepared by the Ministry of Education and Culture 2015–2019 was strongly based on the organisation-level policy work in open science and research. In this monitoring model, the approach has been further developed. In addition to the existence of documentation, the survey also specifies the contents of the documentation and their relation to national policies.

Key indicators that influence the determination of organisational levels to be collected through the survey in 2022:

1. Does the organisation have guiding documents regarding open science and research in accordance with national and international policies?
2. Are the guiding documents openly available?

2.2 COOPERATION

Cooperation is essential in promoting of open science and research. As research is international, national open science and research cooperation is closely linked to international advancement of open science and research and to the services and policies created therein.

Cooperation in advancing open science and research in Finland is largely based on the use of working time of experts working in organisations to promote shared objectives and tasks. It is both participation in the coordination of open science and research as well as cooperation with other organisations.

The purpose of monitoring is to highlight the power of cooperation and the resources organisations use to work towards

common goals. Development of indicators that demonstrate cooperation will be examined and cooperation will be added to monitoring in 2024. Where possible, the monitoring of cooperation will make use of qualitative methods, which may take the form of case studies on cooperation.

Future perspectives and proposed indicators to be developed for 2024 at the earliest:

1. Indicators that highlight cooperation, with a focus on qualitative indicators.

2.3 CULTURE OF OPEN SCHOLARSHIP

2.31 EVALUATION AND INCENTIVES

Development of research and researcher evaluation and assessment is one of the main drivers for promoting open science and research practices. The work carried out by a researcher to advance open science and research should be taken into account in organisations as described in the **Recommendation for the responsible evaluation of a researcher in Finland**[11]. Responsible evaluation of and incentives for open science and research are also outlined in the Policy for Open Scholarship (2022)[12].

2.32 EVALUATION AND INCENTIVE SERVICES

The change in evaluation and incentives needs to be supported by services and infrastructure supporting the evaluation. These questions go beyond the scope of open science and research. However, the key services supporting responsible evaluation have been included in the monitoring of open science and research, as they play such an important role in promoting openness.

Key indicators that influence the determination of organisational levels to be collected through the survey in 2022:

1. Does the organisation use the Recommendation for the responsible evaluation of researcher in Finland? Data source: survey.
2. Does the organisation have internal guidelines to support the implementation of the Recommendation for the responsible evaluation of researcher in Finland? Data source: survey.
3. Has the organisation indicated sufficient services to carry out a qualitative and quantitative evaluation? Data source: survey.

11 https://doi.org/10.23847/isbn.9789525995282.
12 https://edition.fi/tsv/catalog/book/227.

2.33 CITIZEN SCIENCE

The Bank of Finnish Terminology in Arts and Sciences (BFT) (in Finnish)[13] defines citizen science as crowd-sourced research in which people outside the research community can participate.

Citizen science is a topic dealt in the *Policy on Open Scholarship* and in a recommendation supporting the Policy (in Finnish) (2022)[14].

Future perspectives and proposed indicators to be developed for 2024 at the earliest

1. Services that enable citizen science.

2.4 OPEN ACCESS TO PUBLICATIONS

2.41 SCHOLARLY AND PROFESSIONAL PUBLICATIONS

It is essential to monitor the openness of different types of publications in monitoring open science and research. Higher education institutions receive unequal treatment in the monitoring of mere peer-reviewed research publications. The monitoring of professional publications is an exception to the general principle of monitoring only objectives outlined in the formal policies.

The monitoring of publications in Finland is advanced and it is thus possible to also include other publications. Due to the funding model of universities, open access to publications produced by research organisations is already monitored very closely in the VIRTA database, which is also used in the monitoring of open science and research. Openness of non-peer-reviewed publications will be outlined at a later stage.

The Policy for Open Access to Research Publications (2019)[15] defines immediate open access as an objective, and thus monitoring focuses on monitoring immediately openly accessible publications. Immediate open access refers to the publication of a peer-reviewed version of an article as an open access document in the publisher's channel or using a repository route provided by the researcher's/research organisation's channel without any embargoes by the publisher. The objective of immediate open access does not require any specific way of agreeing on reuse rights or licences for publications. In addition to the open access to publications, monitoring also includes, in accordance with the Recommendations on open access to research publications for research organisations (2020) (in Finnish)[16], also includes the structures, policies, services and incentives supporting the open availability of publications.

13 https://tieteentermipankki.fi/wiki/Avoin_tiede:kansalaistiede.
14 https://doi.org/10.23847/tsv.230.
15 https://doi.org/10.23847/isbn.9789525995343.
16 https://doi.org/10.23847/isbn.9789525995367.

Quantitative indicators used in the monitoring to determine the level of open access to publications in 2022 per organisation:

1. The number and share of scholarly peer-reviewed articles that are immediately openly accessible (OKM publication record types A, excluding A3, and open access in OA/hybrid channels and parallel records), development. Data source: VIRTA.
2. The number and share of parallel publishing (OKM publication record type A, excluding A3, and types B1, B3, D1, D3, and E1), development. Data source: VIRTA.
3. The number and share of articles in professional journals and popular publications that are immediately openly accessible (OKM publication record types B1, B3, D1, D3, and E1, and open access in OA/hybrid channels and parallel records), development. Data source: VIRTA.

National indicators for the development of openness access 2022

1. The total cost of open access publishing. Data source: FinELib, Open APC (VIRTA interface), Publication Forum portal, organisations' own data collection, parallel storage[17]. Information on total costs will be collected as an independent part of the survey.
2. Openness of Finnish and foreign publishing channels used by Finnish researchers (directly open so-called Gold OA channels, and channels that allow a peer-reviewed version to be stored in parallel without delay). Data source: Publication Forum portal.

Future perspectives and proposed indicators to be developed for 2024 at the earliest:

1. Open peer review, e.g., researchers participating in open peer review, open peer review publications, Finnish publication channels using open peer review.
2. Number and use of pre-print publications (requires development of the VIRTA service).

2.42 THESES

Theses are public documents, but not automatically open and discoverable. Educational institutions have their own practices regarding publishing and archiving of theses. Finnish higher education institutions and research institutes have publication archives open to everyone. They can be organisation-specific or shared systems, such as Theseus[18] or Doria[19]. The openness of the theses will be outlined later.

17 Vilén, Timo et al: Kirjoittajamaksut ja niiden seuranta: havaintoja ja kehitysehdotuksia. FinELibin Open APC -projektin loppuraportti. Kansalliskirjaston raportteja ja selvityksiä [23] (in Finnish), 2021. http://urn.fi/URN:ISBN:978-951-51-7163-4.

18 https://www.theseus.fi/.

19 https://www.doria.fi/.

Quantitative indicators regarding theses used to define the level of organisations in 2024 at the earliest:

1. Openly available theses (OKM publication record type G). Data source: Publication Archives, Theseus, study information systems.

2.43 PUBLISHING SERVICES

Monitoring of publishing services is based on the Self-Assessment Tool for Services (in Finnish) (2022)[20], which specifies the *Policy of Open Scholarship*.

Key indicators that influence the determination of organisational levels to be collected through the survey in 2022:

1. Means to ensure equal access to services. Data source: survey.
2. Service coverage. Data source: survey.
3. Incentives for and assessment of open access publishing. Data source: survey.

2.5 OPENNESS OF DATA AND RESEARCH INFRASTRUCTURES

2.51 RESEARCH DATA AND METHODS

Monitoring must encourage good and responsible management of data and versatile management of methods. The FAIR principles[21] (findable, accessible, interoperable and recoverable) provide the backbone for the monitoring of data and methods and also give rise to the requirement for metadata quality.

When assessing the implementation of the FAIR principles, consider the fact that it may not be possible to, for example, for ethical or legal reasons, provide open access to the data. Therefore, a key indicator in monitoring is the development of research metadata and open access thereof. The research.fi service has a research data section, the data of which is sourced through the Metax service and will also be used in monitoring.

There is no open software monitoring tool for the time being. Data on software (Class I) (in Finnish)[22] is included in Ministry's publication record, but at the moment, it is very rarely reported. However, open access to research software and methods is an important part of open access to research data. This monitoring process will seek to monitor and encourage the increased openness of software and other methods. Open access to software will be dealt in a Policy on Open Access to Research Methods and Infrastructures, which is currently being prepared and which will be completed in 2022.

20 https://doi.org/10.23847/tsv.231.
21 https://doi.org/10.23847/tsv.231.
22 https://wiki.eduuni.fi/pages/viewpage.action?pageId=133792351.

Key indicators that influence the determination of organisational levels to be collected through the survey in 2022:

1. Does the organisation provide a data management tool for all researchers? Data source: survey.

Indicators for defining the level of organisations for monitoring open access to data in 2024 at the earliest:

1. Metadata. Data source: Metax.
2. Support for open access to methods: Data source to be determined by a policy component in 2022.
3. Number of open data/datasets based on metadata **OR** downloads of open datasets, reuse (in publications) and references. Data source: Metax.

National Openness Development Indicator 2022:

1. Long-term Storage (e.g., number of datasets and publications transferred to the CSC's PAS service and their share of all datasets and publications). Data source: PAS service, Metax.

Future perspectives and proposed indicators to be developed:

1. DMP monitoring: DMP amounts, their assessment by organisations.
2. Compliance with FAIR principles.
3. Monitoring of open access to methods and software.
4. Monitoring of pre-registrations.
5. Open access to descriptive metadata.
6. Linked data and/or PID graph.

2.52 INFRASTRUCTURE

Research infrastructures include both infrastructures producing research and research data as well as infrastructures supporting (open) research. According to the Academy of Finland[23], "Research infrastructures are instruments, equipment, information networks, databases, materials and services that serve to facilitate research, promote research collaboration and reinforce research and innovation capacity and know-how. Research infrastructures may be single-sited, distributed or virtual, or a combination of these. Europe hosts several large-scale research infrastructures that are open to collaborative use across national boundaries."

A research infrastructure may be managed by a single organisation and used only by its own research teams, or it can be a large national or international entity managed jointly by several organisations. Research infrastructure may also provide services for companies, among other things.[24] Information

23 https://www.aka.fi/en/research-funding/programmes-and-other-funding-schemes/research-infrastructures/.

24 https://research.fi/en/service-info.

on the Academy of Finland's FIRI entity and other national infrastructures is available in the Research Information Hub.[25]

The EOSC portal[26] compiles information on European research infrastructures. One of the tasks of the EOSC is to create a meta-infrastructure that binds together the various national and international systems that produce and store research data and the infrastructures that support research. However, the EOSC portal currently consists of individual services, the permanence of which varies.

In the autumn of 2021, the Open Science and Research Coordination established the Open Science and Research Architecture Working Group, which refines the concept of infrastructure from the perspective of open science monitoring. Monitoring of infrastructures will begin in 2024 at the earliest when the architecture work is completed. In the 2022 monitoring, research infrastructures are only touched on in a question concerning the guiding documents on organisation-level research infrastructures. This question is included because it is asked by the European open science monitoring and thus allows the comprehensive compilation of information on Finnish guiding policies.

Indicators for defining the level of organisations for monitoring open access to infrastructures in 2024:

1. Visibility of research infrastructures and access policies in the Research Information Hub. Data source: Research Information Hub.

Future perspectives and proposed indicators to be developed:

1. Monitoring of the utilisation rate of research infrastructures: references and referencing practices.
2. Indicators, standards and/or recommendations under development in the EOSC, as well as data resources containing information on infrastructures of all sizes, such as Open Iris.

2.53 DATA AND INFRASTRUCTURE SERVICES

Services support equal opportunities for researchers to publish their research data openly and emphasise good data management, as well as the visibility and usability of infrastructures. Investing in services promotes more efficient use of resources in research organisations.

25 Organisations providing information to the Research Information Hub (in Finnish): https://wiki.eduuni.fi/pages/viewpage.action?pageId=145298213#Tutkimustietovarannonyhteisrekisterinpit%C3%A4j%C3%A4t-InfraTUTKIMUSINFRASTRUKTUURIT.

26 https://eosc-portal.eu/.

The monitoring of data and infrastructure services is based on the *Self-Assessment Tool for Services*, which specifies objectives set out in the *Policy of Open Scholarship*.

Key indicators that influence the determination of organisational levels to be collected through the survey in 2022:

1. Training to enable open access to data. Data source: survey.
2. Equal access to support services. Data source: survey.
3. Coverage of open data services. Data source: survey.

2.6 OPEN EDUCATION

Open education is an evolving area of openness and its monitoring will be developed alongside other developments. Previous monitoring data is scarce. The key task is to find suitable indicators after the first years of monitoring.

The Policy Component on Open Access to Educational Resources (2020)[27] sets targets for a clear increase in the quantity and quality of open educational resources and for the use of open educational resources within and outside the higher education and research community.

The policy component for open educational practices will be completed during 2022. The key tools and indicators will be specified as the policy is completed.

2.61 OPEN EDUCATIONAL RESOURCES

In the *Policy Component on Open Access to Educational Resources* open educational resources are defined as materials or information in any form and used on any medium, partly designed for teaching and learning purposes, which have been released for public use (public domain) or shared by an open licence that permits no-cost access, re-use, re-purpose, adaptation and redistribution.

In particular, the national Library of Open Educational Resources (aoe.fi), in which the educational resources can be stored or linked, is defined as the subject of monitoring in the policy component. In addition, the policy component recommends that at least the metadata for educational resources be brought to the Library of Open Educational Resources in order to enable the monitoring of their quantity.

Quantitative indicator used to define the level of organisations in 2022:

27 https://doi.org/10.23847/isbn.9789525995404.

1. The number of open educational resources stored or linked to the Library of Open Educational Resources. Data source: aoe.fi.

Future perspectives and proposed indicators to be developed:

1. Downloads of open educational resources stored in the Library of Open Educational Resources. Data source: aoe.fi.

2.62 SERVICES FOR OPEN EDUCATION AND EDUCATIONAL RESOURCES

The services support equal opportunities for teachers, researchers and learners to use, compile and publish open educational resources, and to use and promote open education. Properly organised services enable the development of high-quality and accessible open educational resources in accordance with the Recommendations (2021)[28] for *Policy on Open Access to Educational Resources* and ensure that the organisation's staff have the opportunity to acquire the necessary skills to promote open education.

In addition to national recommendations, the monitoring of services for open education and educational resources is built on the *Service Self-Assessment Tool*, which specifies the *Policy of Open Scholarship*.

Key indicators that influence the determination of organisational levels to be collected through the survey in 2022:

1. Training to ensure open education skills.
2. Services incidental to the copyright and l icensing of educational resources.
3. Discovery of open educational resources.
4. Application of quality criteria to open educational resources.
5. Accessibility services for open educational resources.
6. Encouragement towards open education.

Future perspectives and proposed indicators to be developed:

1. Application of quality criteria to open education.
2. Use of open source software in teaching.
3. Availability and accessibility of learning environments.
4. Services for open distribution of learners' study outputs.
5. Utilisation of open materials in teaching.
6. Open courses.
7. Implementation of scientific communication and science education.

28 https://doi.org/10.23847/tsv.84.

APPENDIX 1: PREPARATORY WORKING GROUP

ORGANISATION	REPRESENTATIVE
ARENE	**Seliina Päällysaho**
CSC	**Hanna-Mari Puuska**
FINN-ARMA	**Anne Sunikka**
FUN	**Pekka Olsbo**
JUFO	**Janne Pölönen**
NATIONAL LIBRARY OF FINLAND	**Kristiina Hormia-Poutanen**
FINNISH UNION OF UNIVERSITY PROFESSORS	**Petri Mäntysaari**
ACADEMY OF FINLAND	**Riitta Maijala**
FINNISH UNION OF UNIVERSITY RESEARCHERS AND TEACHERS	**Salla Viitanen**
TULANET	**Katja Hilska-Keinänen**
RECTORS' COUNCIL OF FINNISH UNIVERSITIES UNIFI	**Kalle-Antti Suominen** (President) (Chairperson)
FEDERATION OF FINNISH LEARNED SOCIETIES	**Henriikka Mustajoki** (Presenter)
FEDERATION OF FINNISH LEARNED SOCIETIES	**Ilmari Jauhiainen** (Specialist)
FEDERATION OF FINNISH LEARNED SOCIETIES	**Elina Koivisto** (Secretary)

APPENDIX 2: CHANGES TO THE SCORING PRINCIPLES OF THE LEVELS OF OPENNESS

In consequence of the decision taken by the National Open Science and Research Steering Group in the meeting on 12 Oct 2022 this listing on pages 12 and 13 was replaced with a new one:

- **Openness level 5:** The average degree of the profile's areas is 3.5. All areas reach at least degree 2.
- **Openness level 4:** The average degree of the profile's areas is 3. All areas reach at least degree 2.
- **Openness level 3:** The average degree of the profile's areas is 2.5. At least three areas achieve degree 2.
- **Openness level 2:** The average degree of the profile's areas is 2. At least two areas achieve degree 2.
- **Openness level 1:** The average degree of the profile's areas is 1.5.

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