Toolkit

Open science

Introduction

What is open science?
Open science encompasses the idea that all scientific knowledge that is gathered should be accessible to everyone.

Aspects of open science

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- I have been hired on an existing project
- I have my own funding
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What if open science is not an option?

- Knowledge security
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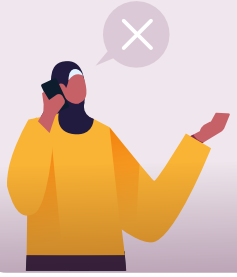
- Academic journals



Engaging in conversation about open science
A training course in conversation techniques that focuses on discussing open science

Open science at NWO Institutes
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About this toolkit

This toolkit has been developed for employees at the NWO institutes who work on scientific research. This toolkit offers an explanation about the different aspects of open science, tools to get started with open science or to engage in dialogue within your institute. In addition, this toolkit contains many links for further information. Finally, you will see how open science is embedded within NWO-I. The purpose of this toolkit is to provide the broadest possible picture of open science, so that you can use it in a way that suits your work.

Open science encompasses the idea that all scientific knowledge that is gathered should be accessible to everyone.

Why open science?

Open science encompasses the idea that all scientific knowledge that is gathered should be accessible to everyone.

Open science encompasses the idea that all scientific knowledge that is gathered should be accessible to everyone. The term open science is a broad concept. For more information on what we mean by open science, please see What is open science? and Aspects of open science

There are various reasons why knowledge should be openly available. In 2013, researchers Fecher & Friesike identified five possible underlying reasons as to why open science is important. Frequently mentioned reasons are:

- Research is made possible largely through taxpayer funding, such as grants made available via NWO. Research results thus have to be available to all tax payers.
- Science can become more efficient and more effective when research is freely available to everyone. Researchers can build on the works of others more easily if this work is openly accessible.
- By making publications, datasets and other forms of output freely available, research can be better replicated and falsified. This argument is also often cited in relation to research integrity.

Making the project largely open science also offers an opportunity to enhance its profile. It has, for example, been demonstrated that open-access publications are cited more often. As employees, you should be given the opportunity to do this. Also, see the chapter 'Engaging in conversation about open science'.

'As open as possible, as closed as necessary'

Even if you support the principles of open science, there may still be justifiable reasons to decide not to make publications or data openly available. This might be for reasons involving knowledge security or due to a partnership with industry. You have to have a valid reason not to make your research accessible. This is part of research integrity. Also, see What if open science is not an option? and the NWO-I Research Integrity toolkit.

Open science policy

NWO institutes

NWO-I adheres to the principles of open science and is therefore committed to making research publicly available as much as possible. The aim is to make 100% of the publications by the institutes open access. We also seek to make data and software publicly available as much as possible. In doing so, we adopt national government policy.

The Netherlands

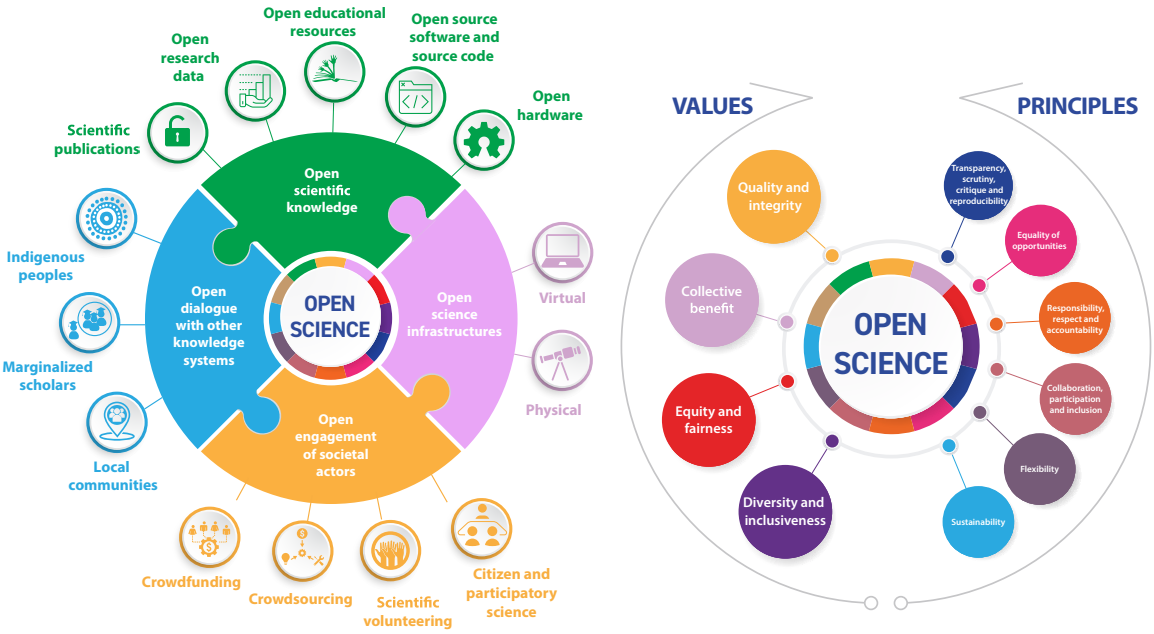
The Netherlands has a national open science programme. In 2022, it published a vision document for open science in 2030. The national programme was incorporated into OpenScienceNL in 2023, an NWO task force which has been providing funding to promote open science since then. It is supported by the Dutch Ministry of Education, Culture and Science.

In addition, open science is one of the main aspects of the Strategic Evaluation Protocol (SEP), a six-yearly evaluation of all research units in the Netherlands. Also, proposals to NWO, the research council of the Netherlands, have to comply with the principles of open science.

Europe

In 2018, the European Commission decided that all research funded by the European Research Council (ERC) must adhere to the principles of open science. It is for this reason that the EU supports different initiatives to enable open science. In addition, all research funded by the EU Horizons2020 programme, such as ERC grants, consolidator grants or large-scale collaborations, must comply with the principles of open science. Also, UNESCO facilitates open science in Europe. Check here to see UNESCO's viewpoints.

What is open science?



Source: UNESCO open science toolkit factsheet

The concept of open science is as broad and diverse as the reasons for adopting its principles. Most researchers will be familiar with concepts such as open scholarly communication or open access (i.e. openly publishing scientific articles and other works), open research data or open data (i.e. making research data available), and open source or open software (i.e. sharing the code and software underlying experiments and data analyses). However, there are even more ways to apply open science. UNESCO refers to 'open dialogue with other knowledge systems' and 'open engagement of societal actors', among other things, the latter of which also includes citizen science. In addition, the 'open scientific infrastructures' are relevant for the NWO institutes, whereby access can be both physical, such as libraries and research facilities, and digital.

What open science means to you, and why you choose to engage in it, depends on the values and principles that guide your research. The UNESCO working group has listed a number of values and principles. This toolkit also gives some examples of aspects of open science with specific examples and specific resources.

Aspects of open science

Open Scholarly Communication

Open Scholarly Communication is a collective term for making research publications publicly available, such as peer-reviewed articles and books. This is also referred to as open access.

From subscription to pay-to-publish

In the previous century, it was common to publish in academic journals to which scientists and the libraries of knowledge institutes held subscriptions. This is also known as the classic 'subscription model'. With the advent of the internet and the open science movement, increasing attention was given to making scientific output publicly accessible. This has resulted in different ways of open access publications.

Open access 'routes'

There are different ways of open access publications which are also referred to as routes:

- The **green route**: the full text of a publication is filed in a reliable, publicly-available repository. This could be the publication itself (the Version of Record), a version following a peer review (also known as the Author Accepted Manuscript or postprint), or a version prior to a peer review (a preprint).
- The **golden route**: the article is published in a fully open access journal. The author, or its institute, pays an Article Processing Charge (APC) for this.
- The **diamond route**: the article is published in a fully open access journal, without having to pay any costs towards publication. In order to maintain the journal, it is subsidised by libraries, knowledge institutes and societies.
- The **hybrid route**: the article is published in a subscription journal and made publicly available by paying an APC.

Making publications publicly available is supported by the libraries of the NWO institutes and promoted nationally by the Dutch university libraries.

How can I do this?

NWO, and thus the NWO institutes, has committed itself to open access publishing. The NWO-I policy framework indicates that articles have to be instantly made publicly available. The green route is recommended to achieve this in a cost-efficient manner, but other means, such as the diamond route, are also an option. The NWO-I web page on open access explains what this means.

Where can I turn to?

- Open Journal Browser: browser listing journals that offer open access plus the amount of APCs
- The librarians of the NWO institutes

Open Research Data

Open research data or open data, along with open access, are usually mentioned first when it comes to open science. The idea of open research data stems from two sentiments. The first sentiment is that research can be conducted more quickly and efficiently when all data are openly available. By making collected data accessible, we prevent others from having to gather the same data again, thereby avoiding duplication of effort. Moreover, existing data could be re-used to answer new research questions. The second sentiment stresses that publicly sharing data benefits research integrity. The availability of data enables others to verify whether the research has been conducted in a thorough manner. Analyses and research results are also more easily replicated when all data are openly available.

How can I do this?

You can publish your data on a server or repository of your own institute or you can make use of well-known, general initiatives such as: Zenodo, OSF or GitHub. The advantage of this is that your data receive their own DOI, allowing both you and others to cite your data in publications. This can result in extra visibility.

Before publishing your data, be aware that these data must also be understandable to others. What types of data are these? What do all labels stand for? Which data are in which column? This is also referred to as metadata. Also, consider a possible licence on your data. You could also consider linking an open notebook to your data, in which you describe what you did with your data.

Where can I turn to?

- NWO's manual containing all considerations you may take into account when making your research data publicly available
- Your institute's data management policy
- Possible data stewards or software engineers of the NWO institutes

Open Software

If you have created software or a code to enable your research, you may consider making these publicly available. The idea of open source or open software is the same as the notion of open research data and stems from two sentiments. The first sentiment is that research can be conducted more quickly and efficiently when all software is openly accessible. By making code and software that has been developed accessible, we prevent others from having to do this anew, thereby avoiding duplication of effort. Moreover, existing software could be re-used to answer new research questions. The second sentiment stresses that publicly sharing software benefits research integrity. The availability of software enables others to verify whether the research has been conducted in a thorough manner and whether the results can be replicated.

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If you decide to publicly share your software, you will also need to think about issues such as version control and updates and how you will inform potentially new users thereof. The software sustainability institute refers to a website, a mailing list, an issue tracker and a code repository, as examples.

Where can I turn to?

- Software sustainability institute has a website filled with information about this subject. It also includes more possible repositories
- Software engineers of the NWO institutes

Open Hardware

If you have created hardware to enable your research, you may consider making this hardware, or the instructions to build it, available for other researchers. The concept of open hardware stems from principles such as transparency, inclusivity, sustainability and efficiency. Research can be conducted more quickly and efficiently if all hardware is openly available: it saves resources and development costs if we can share existing hardware or blueprints for hardware with each other, and existing hardware can potentially be reused to answer new research questions. Publicly sharing hardware also benefits research integrity. It makes it easier for others to verify whether the research has been conducted in a thorough manner and whether the results can be replicated with the hardware.

How can I do this?

You can make your hardware available on the OpenHardware.io platform, for example.

Where can I turn to?

- Open Hardware Academy of TU Delft offers a ten-week programme to learn how to create Open Hardware. The physical lessons have not been recently updated, but all teaching materials are readily available on the website, such as information on the concept of Open Hardware and help in design and prototyping

Outreach

The idea that science should be accessible to everyone, including non-scientists, stems from the fact that science is generally funded by public resources. Therefore, everyone should be able to take note of it. *Outreach* can be seen as making science accessible to a general, interested public. Examples of outreach include giving presentations to a general public or writing blogs or columns for non-experts.

How can I do this?

There are different annual initiatives in which NWO institutes participate, or which researchers or technicians can join. One example is het *Weekend van de Wetenschap* (Science Weekend), or the annual open house of the institutes. You could also join initiatives such as Pint of Science. The ASBMB website has a list of more outreach ideas.

Where can I turn to?

- Your institute's Communications Department
- *Nationaal expertisecentrum voor wetenschap en samenleving (NEWS,* National Centre of Expertise for Science and Society): NEWS can offer advice on how to communicate about your research to non-scientists

Citizen science

Another way of making research accessible to non-scientists is by involving citizens in the actual research. Citizen science is a form of research that provides non-scientists the opportunity to be involved in science by 1) formulating relevant research questions or 2) the actual research. Relevant research questions are often formulated by patients or other target groups who are closely involved in the research to be conducted. Additionally, non-scientists can assist in the actual research by, for example, taking measurements, such as bird counts or noise pollution measurements, or by willingly sharing their own personal or non-personal data.

How can I do this?

Citizen science often begins prior to the start of the research. The extent to which non-scientists can be included in the research depends on the purpose and type of research. Be sure to draw inspiration from existing citizen science projects.

Where can I turn to?

- Website with citizen science projects in the Netherlands
- European platform for citizen science projects
- National Geographic's citizen science projects
- Citizen science projects in Amsterdam
- NWO regularly publishes calls to initiate citizen science projects

Open Education

Creating teaching materials or giving lectures can also be seen as sharing and communicating research results. If you make education, such as teaching materials, publicly available, this would be referred to as open education, or OER, Open Educational Resources, or MOOCs, which stands for Massive Open Online Courses.

How can I do this?

You can often upload your teaching materials or presentations for a lecture to a dedicated repository. Maastricht University has created a useful overview of places where you can upload Open Educational Resources.

Where can I turn to?

- SURF hosts a community about open education that regularly shares information and examples

Getting started with open science

Open science is more than a theory: an increasing number of funders or governments stress the fact that open science needs to form an integrated part of the research process. NWO-I, too, adheres to the principles of open science and is therefore committed to making research publicly available as much as possible. Even though there are many opportunities allowing research to be conducted according to the theory of open science, it may sometimes be difficult to get started. The best way to start with open science depends on your own position. We outline these different situations below and provide tools for this. We will also discuss how you can best open up the conversation about open science.

I have been hired on an existing project

If you have been hired to work on an existing project or established funding, you often have not been directly involved with the initial project or grant application. This sometimes makes it difficult to make changes to the project plan in retrospect. Still, it would certainly be worthwhile to initiate the conversation about open science at an early stage. The following things can be discussed:

- Which conditions and prerequisites with regard to open science are associated with the funding?
- What plans are in place for making data, software, and other research data openly available? Is there a data management plan, or should one still be made?
- Who will be responsible for what with regard to making the research open science? How much time has been made available to achieve this?
- In what way will publications about the research be made open access, and is there budget available for this? Will you publish a preprint?
- Is pre-registration an option for your project? This allows you to inform the world in advance about what your project will entail and what publications are to be expected.
- What support is available to help you with different aspects of open science?

I have my own funding

If you have started a research project yourself or are about to do so, it may be a good starting point to review your values and principles and consider which forms of open science are appropriate for you and your project. Consider outreach activities or a type of citizen science. Also think of the following:

- Be aware of the conditions and prerequisites with regard to open science that are associated with the funding.
- Which skills associated with open science do you already have and which ones require more in-depth focus? See Aspects of open science for useful links.
- Making your research openly available takes time. Please keep this in mind in the planning of your project.
- Think about the support you can request to help you realise your open science goals. You might think of using data stewards. Specific tasks may be assigned to team members. This helps you to arrive at a type of team science.
- Consider pre-registering your project. This allows you to inform the world in advance about what your project will entail and what publications are to be expected.
- Make a plan for making data accessible. A data management plan ensures that you carefully consider and document the process of organising and sharing your data. Many funders, including NWO, ask for such a plan when you submit your proposal or after it has been approved.
- Also, consider making other possible outputs of your project publicly available, such as any methods you may have developed (you could publish these as a preprint or via a specific journal) or, for example, any software you may have developed. Sometimes, there are already specific spots in each field or at your own institute where this extra output can be shared openly. Otherwise, spots such as the Open Science Framework (OSF), GitHub or DANS serve as a good starting point.
- Before submitting your final manuscript to a publisher, you can publish it as a preprint. You then make your publication accessible via the green route.
- Consider where you would like to publish and how you can ensure that your publication will be open access. Check to see whether you can make a budget available for this, if needed.

I want to apply for a grant

Most large research councils such as NWO and the European Horizon programmes have specific requirements for making research funded by them openly accessible. NWO instructs applicants to fill in a data management section when applying for a grant and to submit a data management plan once the grant has been awarded. Moreover, all European funded research has to be directly openly accessible.

- Given that open science is the core value of most research councils, it is worthwhile to describe your commitment to making your research publicly accessible when writing the grant proposal. You can also reflect this in the expected output of your project, the planning and the budget.
- Realising open science requires effort, time and sometimes even money. Consider making data, software, or even hardware publicly available. Therefore make sure that there is enough room in your plans to annotate a dataset with solid, clear metadata, for example.
- From the outset, take into account aspects such as the time you need to organise citizen science or outreach in your planning. This will save you from unplanned work pressure and project delays.
- When writing the proposal, also take into account any additional 'human resources' required to comply with open science.

Want to think further ahead? Check the items under 'I have my own funding'.

Engaging in conversation about open science

Within the framework of the leadership programme, NWO-I will offer a training course in conversation techniques that focuses on discussing open science from 2026 to 2028.

Working according to the philosophy of open science sometimes also requires a different type of consultation, or the ability to communicate with other people or about subjects other than you are used to. How will you and your colleagues code and archive the research data in order for them to be retrievable, recognisable and transferrable? Who will do what, and where can you help one another? When will you do it and how will you find the time for it? Suppose that someone requests your research results, what kind of accompanying explanation will they need? How will you go about this? In the training course, you will practise formulating clearly and making clear agreements.

Where can I turn to?

- More information about the training course can be requested via strategy@nwo-i.nl

What if open science is not an option?

Although Dutch science and the NWO institutes pursue and comply with the principles of open science, there are exceptional situations where this is difficult to realise. There may be justifiable reasons to not share research results. However, this decision must not be made lightly. This chapter describes three possible situations in which openly sharing your research may not be possible or may be put under pressure and how you can best deal with this.

Knowledge security

The 'National Knowledge Security Guidelines: secure international collaboration' were published in 2022. The knowledge security policy comprises three aspects:

- Preventing undesirable transfer of sensitive knowledge and technology and the risk of adverse consequences for national security and Dutch innovative capacity.
- Preventing the covert influencing and interference by state actors which can lead to self-censorship and the impairment of core academic values.
- Identifying ethical issues that can be at play in collaboration with persons and institutes from countries that do not respect fundamental rights.

In short, knowledge security policy sometimes involves striking a balance between open science and national security. Not all research that comprises sensitive knowledge or technologies can be easily shared publicly. If the research could also be exploited by state actors with malicious intentions, caution should be exercised when sharing it. The same applies if it can jeopardise national security, or if the information could be deployed to violate human rights, such as the right to privacy which may be violated to an unacceptable degree by surveillance techniques.

More information about knowledge security is available in our NWO-I knowledge security toolkit. If in doubt about whether knowledge security considerations apply in making your research openly available, please contact the knowledge security contact person at your institute.

Collaborations with the industry

If you are working on a research project that is funded or partly funded by an industry partner, that partner may set certain conditions regarding the collaboration and the extent to which the project's output can be made publicly available. When establishing a collaboration with an industry partner, it is recommended to formalise clear agreements regarding the public availability of research data and results, and the management of intellectual property arising from the research. This may also impact the limits to making research results available to third parties. In these situations, seek expert assistance from, for example, the Legal Affairs Department of the NWO-I office, when making agreements that safeguard the principles of open science as effectively as possible.

For example, in a contractual agreement, the partner may claim a delay in publication if a potential patent can be developed. The industry partner's funding does not warrant exclusive rights to the output of academic research.
For more guidelines and frameworks, see the Netherlands Code of Conduct for Research Integrity or **the NWO-I toolkit for research integrity.**

Academic journals

The conclusion of a research is commonly followed by a publication. In such cases, the principles of open science may also sometimes be compromised. As an example, a journal does not offer any open access options, or the APCs are too high. It may also be that the journal does not provide enough space to share all methods or does not offer any possibilities for sharing data. There are some options you could consider:

- Consider publishing your research with another academic press or in another journal. Depending on your own reasons for open science, it may be an option to publish your research in a diamond open access journal, for example. A diamond open access journal publishes all research in open access without charging any APCs and thus serves as an alternative to commercial publishers. Did you know that NWO supports journals to switch to diamond open access journals?
- Consider publishing a preprint before contacting a journal. This is how you share your publication in open access via the green route.
- Publish your data, methods or software on an independent (in-house) platform such as your institute's server or repository, Zenodo, OSF or GitHub, and create a link in it to your article. The advantage of this is that your data get their own DOI and that you and others can quote your data in their articles.

Open science at NWO Institutes

NWO-I is a foundation that consists of ten research institutes and an umbrella organisation. These are supervised by NWO, the Dutch Research Council. NWO has three tasks: to act as a funding council, liaison and an executive body. The institutes are the executive bodies.

NWO endorses multiple treaties, coalitions and parties that subscribe to open science principles or try to promote these. These are also relevant for the institutes, given the interconnectedness of NWO and NWO-I. Below is a list of initiatives supported by NWO:

Funder:

- OpenScienceNL
- Different open science infrastructures

Coalitions:

- San Francisco Declaration On Research Assessment (DORA)
- Plan S
- Coalition for Advancing Research Assessment (CoARA)
- Recognition and Rewards
- Barcelona declaration

NWO-I also has a few initiatives of its own. NWO-I has, for example:

- The NWO-I Digital Competence Center (DCC): The DCC provides training courses, advice and practical support to researchers, dataset stewards and software engineers.
- A 100% Open Access policy
- An Open Access sounding board group, composed of representatives from the NWO institutes.
- A research data management policy.

Questions and comments

- If you have any questions about open science or this toolkit, please contact team Governance Support & Strategy at NWO-I via strategy@nwo-i.nl