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Content list

1 Preamble

1.1 Purpose

The purpose of this open science code of conduct is to foster the ethos of open scientific practices, open scientific collaboration and communication as well as a culture of joint open, transparent, responsible, inclusive and fair research endeavours. This open science code of conduct aims to make the global scientific community as open, transparent diverse, inclusive, robust, appreciative, responsible and fair as possible. Thus, it expresses ethical values, rules, norms, standards and ideals and codifies them in a tangible form.

See the appendix for *details on open science its benefits and on common misconceptions regarding open science*. See also the *list of other codes of conduct*.

1.2 Scope

This open science code of conduct invites all actors in the scientific field like researchers and research organisations voluntarily committing themselves to the ethical values, principles rules, norms, standards and ideals expressed in this code of conduct in their daily professional scientific practise.

This open science code of conduct may be added to existing project grant agreements and research contracts, or may be integrated in existing best practices or workflows. For further information on how to integrate this code of conduct into your contracts, see section *Consortium agreement*.

Open science is practised by many scientists from all kinds of disciplines all over the world. However, the consistent implementation of open science in research organisations and research projects is often hindered by lack of knowledge, funding and concrete guidelines, agreements or contracts.

This code of conduct enables scientists and research organisations to put open science into practice by giving them a basic template of best practices, principles.

1.3 Open science

Open science is a way of doing science. One of the main goals of open science is to open up the entire scientific process including but not limited to initial hypotheses, planed research endeavours, peer reviews, data, publications etc. as much as possible and to as many people as possible.

- **What is open science?** For further information on open science, see section *Definition of open science*.
- **Benefits of open science**: For the benefits of open science, see section *Benefits of open science*.
- **Facts and myths regarding open science**: For information on what open science is and what open science is not, see section *Common misconceptions*.
- **Open science and intellectual property**: For information on open science and intellectual property, see section *Open science and intellectual property rights*.

1.4 Implementation

1.4.1 Law and contracts

Compliance with the principles and practices formulated here is entirely voluntary and the sole responsibility of the individual scientist or organisation. The principles set forth in this open science code of conduct do not have any legal power per se and they do not substitute or rescind any existing law or contract. In principle, there is no law that requires scientists to do open science. However, this code of conduct can be made mandatory by making it part of a contract. For further information on how to integrate this code of conduct into your contracts, see section *Consortium agreement*.

Some funders of research projects may require open science practices such as open access or open data. In its current framework programme Horizon Europe (HEU), for example, the EU prescribes open access. Within certain limits, the European Commission gives projects the freedom on how to deal with their research output. The H2020 Annotated Model Grant Agreement (AMGA) describes in detail opt-out possibilities for open access results and data. This will *not* change significantly in the upcoming program Horizon Europe, as far as we know. Yet, it is possible that open access will be the default option. If you want to opt-out of open access and open data, you may need to justify this move.

Due to the ongoing preparation of the upcoming funding program Horizon Europe, it remains to be seen what role open science will play. As far as we know from the common understanding of the Rules for Participation in the Framework Programme Horizon Europe, released on March 27th 2019, open science is defined in Article 2 *Definition* explicitly. Further details of the requirements are described in Article 10 of the Rules for Participation. The upcoming Rules for Participation most likely will again focus on the non-restricted access to scientific publications and research data. Research data management should follow the principle “as open as possible, as closed as necessary” (European Commission 2020a) as well as the FAIR principles (GO FAIR 2019). Paragraph three of article 10 leaves room for further implementation of additional open science practices in Horizon Europe calls. (General Secretariat of the Council 2019)

1.4.2 Enforcement

The community or research or project group will sanction violations of this code of conduct or misconducts of good scientific practice like conscious or wilful false statements, intellectual property infringement or plagiarism, spoofing of data, etc. with immediate fair, transparent and appropriate corrective action.

The prosecution of misconduct is carried out with integrity, fairness, transparency and objectivity. Suspected cases are investigated confidential in order to protect affected persons as long as the proceedings are ongoing, since innocence is always presumed until the disproof of the accusation.

1.4.3 Consortium agreement

If you want to include this open science code of conduct in your project, you could incorporate a reference in your consortium agreement. Such a reference may have the following form:

> *“We hereby declare that we commit ourselves to the open science code of conduct version YYYY-MM-DD and its guiding principles.”*

Alternatively, you can only commit to parts of this open science code of conduct by choosing a formulation like the following:

> *"We hereby commit to the open science code of conduct version YYYY-MM-DD with the exception of practice A and B".*

Of course, you can also modify this code of conduct as you wish, as it is licensed under the *CC0 1.0 Universal (CC0 1.0) Public Domain Dedication*. See section *License*.

For more information on how to implement this code of conduct into your projects and organisation, see section *General step-by-step guide*.

2 Open science practices

2.1 Open access

We make our publications freely accessible.

Open access is a practice in which publications are made freely available to as many people as possible. Open access can increase the visibility of your research by making your research results available via the internet to a large number of people worldwide

Examples

There are different ways to publish open access, such as diamond open access, gold open access or green open access. (Suber 2012; Eve 2014) In most cases, you can share your preprints as green open access publications on your own website or on one of the many dedicated preprint platforms like *arxiv.org* (2021) or *bioRxiv.org* (2021). You can use the *Open Science Framework* (OSF 2021b), the new European *Open Access Publishing Platform* (European Commission 2021b), *OpenAIRE* (2021a) or *Sherpa Romeo* (Sherpa Romeo 2021) to find the right open access publication platform or journal for you. For more information on this subject, see *Plan S* (2021) or *Open-access.net* (2021).

2.2 Open data

We make our data freely accessible.

Open data is a practice in which as much data as possible is made freely available to as many people as possible. Open data can increase the quality of your research by making it easier to verify and reproduce your research results.

Examples

If you want to publish your data, you should make sure that your data publication complies with the *FAIR principles* (GO FAIR 2021). You can use *Zenodo* (2021), a very successful data repository platform, to share your dataset as open data publication. *Zenodo* has an excellent *GitHub* (2021) *GitLab* (2021), *ORCID* (2021) and *DOI* (2021) integration. You can find a good overview of where and how you can publish your data at *Nature Recommended Data Repositories* (Nature 2021) and the guideline by *OpenAIRE* (2021c; 2021b). You can use the *re3data* “registry of research data repositories” (re3data.org 2021) to find the right data repository for you.

2.3 Open source

We make the source code of our software freely accessible.

Open source is a practice in which as much source code as possible is made freely available to as many people as possible. Open source software that is created and/or used during the research process, should be freely accessible, modifiable, distributable and re-useable by other researchers. Open source can increase the quality of your research by allowing other people to analyse the algorithms you used. Open source enables the verification of research results and minimizes redundant software developments, which can lead to savings of research funds.

Examples

To make your software open source you need to do two things. First, you need to publish your source code. For this you can use repositories like *GitLab* (GitLab 2021), *GitHub* (GitHub 2021), *Bitbucket* (Atlassian 2021) or *SourceForge* (SourceForge 2021). Second, you need to put your source code under an open licence, such as the *MIT licence* (Open Source Initiative 2021b). For more information on this subject, see the *Open Source Initiative* (2021a), *Wikipedia* (2021g; 2021e), *Choose an open source license* (2021) and *TLDRLegal* (Wang 2021).

2.4 Open educational resources

We make our learning and teaching materials freely accessible.

Open educational resources (OER) is the practice where learning, teaching or training materials such as books, videos, source code or transcripts are made freely available to as many people as possible. Open educational resources contribute to improving equal opportunities for education worldwide. Furthermore, open educational resources are part of the global megatrends of the knowledge society and lifelong learning. By publishing your teaching and learning materials as open educational resources, you are contributing to the education of more people, which can contribute to a bigger, better science community.

Examples

Good examples of open educational resources are the massive open online course (MOOC) platform *edX* (2021) from MIT and Harvard, *Wikipedia* (2021a), the peer reviewed *Scholarpedia* (2021) or formats like *TEDx* or *TED-Ed* (Wikipedia 2021d). To share your OER or search for OER you can use the *OER World Map* (2021) or *OER Commons* (2021). You can also brows the *list of platforms at UNESCO-UNEVOC* (2021). If you want to publish your OER you should use a permissive license like the *Creative Commons* (creativecommons.org 2021; Wikipedia 2021c). For more information on this subject, see *Wikipedia* (2021f), *UNESCO* (2017) or *OER on CC Wiki* (2021).

2.5 Open methodology

We make our methods and methodology freely available.

Open methodology is a practice in which specific methods or the methodology of a subject are made freely available to as many people as possible. The rule of thumb for the practice of open methodology is to document the methods you used rigorously and publish them together with your results as an open access publication. You could publish your research nots via the open notebook approach. You should also preregister your hypotheses or research design (see examples below). Open methodology can improve the quality of your research by allowing other scientists to analyse your methods and reproduce your results.

Examples

When practising open methodology, it is important to be as explicit, concrete, unambiguous and transparent as possible in describing your methods, research designs and hypotheses. To preregister your hypotheses and research designs or methods you can use *Open Science Framework* (2021a), *AsPredicted* (2021) or the *registered report format* (COS 2021b). For more information on this subject, see *Wikipedia* (2021b), *Center of Open Science* (2021a) or *PhD on track* (2021).

2.6 Citizen science

We do science together with citizens.

Citizen science is science that is carried out with both professional scientists and non-professional scientists. The rule of thumb in citizen science is to open your research to people who are not full-time or professional scientists. Citizen science is all about being inclusive and about the integration and engagement of the civil society in research project to make the research life cycle more accessible, transparent and understandable. (Gura 2013; Wikipedia 2020f) The *European Citizen Science Association* formulated a detailed explanation of the different variation and characteristics of citizen science, see Haklay et al. (2020).

Examples

You can search and share citizen science projects or build your own citizen science projects by using platforms like *Zooniverse (2021)*. You can also use platforms like *Citizen Science Association (CSA) (2021)*, *European Citizen Science (ECSA) (2021)* or *EU-Citizen.Science (2021)* to connect or collaborate with like-minded scientists. You can browse the list of tools, platforms and project at *Project-awsome.org (2021).*

3 General step-by-step guide

Step 1: At the very beginning of the project (preferably even *before* submitting the proposal), have a workshop with all partners on the following topics:

1. Intellectual property (foreground and background IP),
2. Data management (including repositories and release conditions) and
3. Publication management and publication strategy (including predicted costs and dates).

In this step, it is important that all partners agree on a common general strategy and commit to the negotiated general contents and rules.

Step 2: At the very beginning of the project (preferably even *before* submitting the proposal), have a second workshop or meeting with all partners on the details of the contents and project results regarding the following questions:

1. Which contents and results of your project will have which technology readiness level (TRL)? In this step, you can use a tool like Table 1.
2. Which contents and results of your project needs to be confidential?
3. Which contents and results of your project needs to be non-disclosed?
4. Which contents and results of your project can be open?

Step 3: At the very beginning of the project (preferably even *before* submitting the proposal), consult the annotated version of the OSCAR code of conduct and try to answer the following questions:

1. Can you commit to the general theme and the general ideas of the OSCAR code of conduct?
2. Do you want to make the code part of your contract?

Step 4: If step 3 was positive, then proceed by incorporating the OSCAR code of conduct by:

1. Explicitly referencing your main contract(s) within the OSCAR code of conduct or by
2. Explicitly referencing the OSCAR code of conduct within your main contract(s).

Step 5: During the project you can follow the motto “as open as possible, as closed as necessary” (European Commission 2020a). See also Table 1.

In principle, the younger the field of research or innovation is, the more complex i.e. challenging the research or innovation problems are. For example, the problems in foundational research are, in general, more complex than those in applied research. Technology readiness levels (TRL) offer a good classification of maturity levels from foundational research to the finished product. (Mai 2015; NASA 2020; EARTO 2014) In this sense, TRL can also offer a great indicator to assess the complexity level of a phase in a research project.

		Open science practices								
		Open access	Open data	Open educational resources	Open source	Open methodology	Open (lab)notebook	Open standards	Open policies	Citizen science
TRL	1-3									
	4-6									
	7-9									

Table 1: Assessment of the applicability of open science practices with the help of the TRL of an item

4 Appendix

4.1 Definition of open science

Open science is a way of doing science. Open science can be understood as a specific way of conducting research. One of the main goals of open science is to make the entire scientific process—including its inputs, outputs and intermediate results such as hypotheses, data, publications, peer reviews, methods etc.—as open as possible for as many as possible. (Bezjak et al. 2018; Fecher and Friesike 2014; FOSTER 2020a; Wikipedia 2020a)

It is important to note that there is currently no generally accepted single definition of open science. The definition given here is the result of a careful compilation of different definitions from different sources. The lack of a consensus on what open science actually is can be interpreted as an expression of the fact that the open science phenomenon is still quite young and is developing organically.

One approach to determine open science is to classify it according to certain principles, practices, characteristics and indicators. This approach is quite salient yet usually implicit in the relevant literature. In the following, we give only an example of such a classification by means of typical practices.

- **Open access**
  The rule of thumb of this practice is to make your scientific publications freely available. (Suber 2012; 2020; Wikipedia 2020e) There are different strategies for publishing according to the open access practice, three of them are (Suber 2012; 2020; Wikipedia 2020e; Schmeja 2018):

  - Diamond open access
    Diamond or platinum open access means that the publication is published in an open access journal. The publisher does not require article processing charges (APC) nor doe they ask the readers to pay. Therefore, these journals or publishers are often financed by third-party funds and donations.

  - Gold open access
    Gold open access means that publications of scientific work are directly published in an open access journal or an open access monography. There exist different ways of how the publications are financed. The most common way is the article processing charges (APCs). These APCs are also charged to the author for conventional, closed publications. Other financing options can be sponsoring, sale of printed versions, support from communities, institutions or organisations (open-access.net 2020). In the case of EU research projects, the European Commission offers to reimburse costs for open access publication (see the H2020 Annotated Model Grant Agreement V5.2 Article 6.2.D.3 “Cost of other goods and services”. The cost must be mentioned when submitting the proposal. For more information see also the H2020 Online Manual) (European Commission 2019).
    (Schmeja 2018; Fuchs and Sandoval 2013).

  - Green open access
    Green open access is the additional publication of scientific work on an institutional repository (open-access.net 2020) like *arXive.org* (2021) or a private website, also known as self-archiving. To be compliant with the H2020 requirements each

publication stemming from a research project funded by the EU has to be published as an open access publication within a period of 6 months. With the help of SHERPA/RoMEO (https://v2.sherpa.ac.uk/romeo/), individual publishers and journals can be compared in terms of their different open access policies and publishing conditions. (Sherpa Romeo 2020; open-access.net 2020; European Commission 2020c)

- **Open data**
  The rule of thumb of this practice is to make your research *data* freely available. (Wikipedia 2020d) In the narrower sense, data means the concrete data records on which the published works are based on. See, for example, the important FAIR Data principles (Findable, Accessible, Interoperable, Reusable). (GO FAIR 2019)

- **Open source**
  Open source software is software whose source code is openly accessible. In the context of scientific work, this means that software that is created and used during the research process, should be openly available, modifiable, distributable and re-useable by other researchers. (Open Source Initiative 2021a; Wikipedia 2020h) Among many other things, open source enables the verification of research results and minimizes redundant software developments, which can lead to savings of research funds.

- **Open notebooks**
  Open (research) notebooks create transparency about scientific primary record of research by not only summarizing the overall results in an article but also providing early insights and documentation into how the research progressed in detail. It can contain diaries, workbooks, laboratory research records, journals etc. (Wikipedia 2020b; Salvagno 2012; FOSTER 2020c)

- **Open peer review**
  In principle, the peer review process increases the quality of scientific publications. Up to now, peer review often took place behind closed doors. A closed peer review is prone to errors and such a closed process can be exploited to push through certain subjective interests unnoticed. An open peer review ensures neutrality and fosters open and fair communication between parties. An open peer review also increases the recognition of the reviewer's work. Examples for open peer review journals are: GigaScience (http://www.gigasciencejournal.com/), PeerJ (https://peerj.com/) and F1000 Research (http://f1000research.com/) (Ross-Hellauer 2017; Wikipedia 2020g; AG Open Science 2020) F1000Research has recently received funding from the European Commission to develop a platform where scientists can publish easily and at no additional cost. (European Commission 2020b)

- **Open educational resources**
  Open educational resources is the practice where teaching or training materials such as books, videos or transcripts are made freely available. It contributes to ensure equal opportunities for education worldwide and it promotes the mega trend towards the knowledge society and lifelong learning. (Wikipedia 2020c; UNESCO 2020)

- **Open methodology**
  The rule of thumb of this practice is to document your scientific methodology and methods and make it freely available. (Open Science AG 2020)

- **Citizen science**
  Citizen science is science that is carried out with both professional scientists and non-professional scientists. The rule of thumb in citizen science is to open your research to people who are not full-time or professional scientists. Citizen science is all about being inclusive and about the integration and engagement of the civil society in research project to make the research life cycle more accessible, transparent, inclusive and understandable. (Gura 2013; Wikipedia 2020f) The *European Citizen Science Association* formulated a detailed explanation of the different variation and characteristics of citizen science, see Haklay et al. (2020).

- **Open infrastructure**
  The rule of thumb of this practice is to make the infrastructure of your research freely available and reusable. (Fecher and Friesike 2014)

- **Open metrics**
  The rule of thumb of this practice is to make the metrics with which you measure the scientific impact freely available. (Fecher and Friesike 2014; FOSTER 2020b)

4.2 Society and open science

Open science is a pluralistic and dynamic phenomenon with many facets. Open science relies on general ethical values, principles and practices that are deeply rooted in society and science. (Düwell 2019) Thus, it is not surprising that open science has many similarities with other fields, movements and initiatives like the responsible research and innovation (RRI) initiative. (European Commission 2021a; FIT4RRI 2021)

In society, we have ethical values, principles rules, norms, standards and ideals that encompass economy, society, politics and other systems. Science is embedded in these normative systems and forms a constructive interdependent relationship with them. In this sense, open science bears a great responsibility towards other parts of our society as a whole. As part of our society, science is also subject to its moral principles and ethical considerations.

It is up to science to take its responsibility, fulfil its duties and obey ethical norms, especially when it acts on behalf of society. This is especially the case when research is funded by public money. Open science can make a real contribution to better connecting itself with society and to taking its responsibilities for example via citizen science. Citizen science is a win-win for society and science.

4.3 Science and open science

Some of the general principles and characteristics of open science are openness and open communication, transparency, reusability, inclusiveness, reproducibility, robustness, fairness and responsibility. Some of the best practices and indicators of open science are open access, open data, open peer review, open methodology, open education, citizen science and open source. For further information on open science, see section *Definition of open science*.

The principles of open science overlap in many aspects with the general principles of good scientific practice. For example, openness and transparency is the precondition for objectivity, reliability, reproducibility and verifiability in the first place. In this sense, every open science practice is also

automatically a good scientific practice. Therefore, open science not only promotes good scientific practice, but is also part of the basis for science in general. Open science is science done right.

4.4 Benefits of open science

Impact, visibility and citation rates

Open access leads (a) to higher citation and (b) to higher circulation rates. (Heise 2018) Heise's (2018) analysis is based on the results of other studies on this topic.

In 2017, three of the most cited journals were open access journals. (Annina Huhtala 2018) A relatively new study by Piwowar et al. (2018) estimates the share of open access to at least 28% of scientific literature. On average, open access publications achieve an 18% higher citation rate than conventional publications. (Piwowar et al. 2018) This result is not an isolated case: according to the meta-study by Tennant et al. (Tennant et al. 2016), 46% of the studies analysed conclude that open access has a citation advantage. In addition to the positive correlation between open access and citation rates, other positive correlations can be observed.

An analysis of published articles on *Springer Nature* shows that "open access articles are more read, cited, and receive more attention than non-OA articles." (Springer Nature 2018) On average, open access articles are downloaded four times as frequently, cited 1.6 times more and receive 2.4 times more attention (according to *Altmetric* (Altmetric 2020)), than closed access articles. (Springer Nature 2018) There is also movement in the journals. In 2017, 16% of peer-reviewed articles were published in open access journals. (Scimago Journal & Country Rank 2020; August and Reply 2018) Within the last three years, open access journals were cited 7% more frequently than closed subscription journals. (August and Reply 2018) Four of the 20 most cited journals were Full Open Access journals. (August and Reply 2018)

Knowledge transfer and innovation

In markets with short innovation cycles, open innovation and, in particular, open defensive publications (prior art) can be a quick and cost-effective alternative to traditional patent protection. (ZIZ Karlsruhe 2020) Innovation performance of some companies can be improved under certain conditions through open innovation cycles. (Brüggemann et al. 2016) Companies can benefit from the simple and fast integration of new research results (open access publications and open data) into agile innovation processes. (Chesbrough 2015)

In context of a more complex scientific or innovation problems, open forms of organisational governance can improve the solution search in context of complex, difficult or fundamental innovation problems. (Felin and Zenger 2014, 916–17)

Trust and partnership

Especially young and small research organisations, companies and start-ups can benefit from a fast and easy flow of information within and between the partners. In this respect open science has great advantages for these companies, because they can find data and knowledge easily and form relevant partnerships early.

The open handling of information between all partners of a research project or company has a trust-building effect. The public also has more trust in a research project or company when it does open science, i.e. when it opens up its knowledge, its data, and its results as much as possible.

Academic research

Open science has the potential to generate innovative research ideas (Open Science and Research Initiative 2014) and more robust scientific findings (The Lisbon Council 2019). When doing open science, efficiency increases because research data, research results, methods and infrastructure are easily available without any paywalls. Open science can help avoid duplication of work. The European Commission could save 10.2 billion € per year using FAIR principles for storing data. (European Commission and PwC EU Services 2018) Another example from an analysis of the European Bioinformatics Institute shows that open research data for the global life science community saves 1.3 billion € per year. (OpenAIRE 2021b) Transparency, an important principle of open science, contributes to ensure the quality of research results by making it more susceptible to scientific rigour. (Open Science and Research Initiative 2014, p.5) Furthermore, open science promotes a standardized modus operandi for worldwide co-operations on similar research topics and thus the scientific community can react faster to scientific misconduct. (Open Science and Research Initiative 2014)

Open science can help young researchers, non-professionals and citizens improve their scientific literacy by providing them free access to educational resources, research data and publications. Furthermore, a commitment to open standards in science can improve trust in science. Additionally, open science can help ensure that scientists receive the recognition they deserve for their work. (Open Science and Research Initiative 2014)

Government and society

The *social impact* of opening up science in general and research results in particular is tremendous. Openness promotes human rights, democracy and equal opportunities. A better and trustworthy information base could lead to transparent and deliberate decisions in politics. Publicly funded research should be accessible to society, the funders of the research, as it may helpsolve key societal challenges (Picarra 2016, p.4). Open science and citizen science in particular can help improve the interaction of the civil society and scientific community. Research can use citizen science to understand societal challenges and get well-grounded feedback. Citizens can build trust in research activities and participate in the process. (Open Science and Research Initiative 2014, p.3) A study of Fraisl et al. shows that some Sustainable Development Goals (SDG) of the United Nations can be achieved via citizen science projects in such a way that each citizen can participate and create benefits for their own local society and take responsibility by their own. (Fraisl et al. 2020).

4.5 Common misconceptions

Open science and open access

Myth: Open access and open science are the same.

Fact: *Open access can be described as a sub-category or practice of open science.* Open access focuses on the free and unhindered access to information like scientific publications or research data. For a detailed discussion of open science and open access, see section *Appendix*. Open access was one of the first practices that came up in the context of the journals crisis in the late 90ies where many public libraries could no longer pay the rising charges for journals subscription. In 2002 the Budapest declaration (BOAI 2015) and in 2003 the Berlin declaration (MPG 2021) were signed by major science organisations and universities. Furthermore, open access was the first practice of open science the European Commission included in their program. Yet, it is very important *not* reducing open science just to open access.

Open access and copyright

Myth: Open access means that I will have no intellectual property right on my publications.

Fact: *Open access means that you publish your publication so that it is available easily and free of charge on the internet. All your copyrights will remain fully intact*. In Horizon 2020, open access is defined as the online access to scientific publications, at no charge to the end-user. Open access only aims at making your work as widely accessible to the public as possible. Open access does mean that you put your publications in the public domain, nor to allow the public to change or redistribute your work without your consent.

Open science and intellectual property

Myth: Open science contradicts the protection of intellectual property.

Fact: *Open science and intellectual property are fully compatible*. The fact that you are conducting open science instead of just normal science has *no* effect on your intellectual property. For a detailed explanation see also chapter *4.2 Open science and intellectual property rights*.

Open science and European projects

Myth: Projects funded by the European Union must necessarily open up all their research.

Fact: *The European Commission's Horizon Europe scientific framework programme will probably give funded projects the freedom to open up their research.* However, the opening of research will probably be the default in the near future. Projects that do not wish to open up their research (opt-out) must justify this. Furthermore, it is allowed to make non-disclosure or confidentiality agreements.

Open science and quality

Myth: Open science leads to a loss of quality in science.

Fact: *Open science leads to more quality in science*. (Brüggemann et al. 2016; Stracke 2020) Open science is a way of doing science, that emphasis good scientific practice. The core principles of open science, such as openness and transparency are fundamental requirements of science in the first place. Those principles and best practices are at the core of high quality research.

The prejudice that open science and especially open access leads to a reduction in quality is partly due to so-called *predatory journals*. Predatory journals are *fake* journals that have no peer review, no review board and no quality control. In addition, predatory journals demand horrendous prices from authors and publish every paid submission without any quality control or editorial work within a very short time (sometimes within a few days). *Predatory journals have nothing to do with open science or open access.* Unfortunately, however, many predatory journals advertise with the open access as a quality seal to fool scientists. Please consult the website *Stop Predatory Journals*: https://predatoryjournals.com/ for more information on that topic. (Stop Predatory Journals 2020)

4.6 Open science and intellectual property rights

As already mentioned in section *Common misconceptions regarding open science*, open science and the protection of intellectual property are *fully compatible*. This section will give a brief overview on intellectual property in the context of open science.

Traditional intellectual property rights (IPR) management focuses on keeping intellectual property under lock and key. The basic idea of traditional IPR management is to allow a company to use the competitive advantages gained through secret i.e. non-disclosed research and innovation to gain an advantage over its competitors in the market, via patents and licenses.

One of the basic principles of open science is to open up the scientific process as much as possible and thus to open up the intellectual property associated with the same scientific process. The basic idea of open science is to make knowledge and other intellectual assets freely available to the scientific community and society for reasons of fairness, good scientific practice, reusability and responsibility towards society. It is important to note that even if you share your knowledge freely with the scientific community or with society, you are *not* giving up your copyrights to a creation. The creator retains all their rights to her creation in any case, even if they share it freely with others, for example by placing it under a free license such as a Creative Commons license (Creative Commons 2020). The only exception is the deliberate and explicit act of exempting one's own work from any restrictions by releasing it to the public domain.

It is fair to say, that conventional IPR management and open science are in a perceived state of tension. If traditional IPR management and open science principles are described in generic terms, one could assume or perceive that open science and conventional IPR management contradict each other. Yet, it is important to note that open science and conventional IPR do not contradict each other, because they are completely distinct categories. In fact, open science and conventional IPR management can be well harmonized because there are *no* logical or conceptual barriers to this.

For example "while open access to research data […] becomes applicable by default in Horizon 2020, the Commission also recognises that there are good reasons to keep some or even all research data generated in a project closed." (European Commission 2020c)

The European Commission endorses the principle as open as possible, as closed as necessary "and focuses on encouraging sound data management as an essential part of research best practice." (European Commission 2020c)

European AAT research covers the scale of (TRL) from level 1 to level 6 (Mai 2015; NASA 2020b; EARTO 2014). Arguably, the TRLs within a project are important factors that might influence how much research can be opened up. See also section *General step-by-step guide*. The more fundamental research is done, the more this research can be opened up. The more applied industry-related research is done, the less the research process can be opened up. Therefore, for the implementation of open science all aspects of the nature of each individual project need to be considered.

When implementing open science in European research projects in general, reasonable compromises between closing and opening the respective project contents must be found. In doing so, special attention must be paid to the respective TRL of the respective project, because TLRs

could provide a good tool to decide where, how and when which assets can be opened. See also section *General step-by-step guide*.

Intellectual property (IP) represents an intangible asset. IP is created actively by creative processes of the human intellect. Examples for intellectual property are: inventions, software, reports, design, music, books, videos, work of art etc. Intellectual property rights (IPR) are a juridical tool to protect the intangible nature of IP. The juridical structure expresses itself as patents, copyrights, industrial design rights, trademarks, trade secret, utility models or database rights. (IPR Helpdesk 2020) See the *European IP Helpdesk* for more information on this subject.

4.7 Other codes of conduct

- **The European code of conduct for research integrity**
  https://allea.org/code-of-conduct/
- **Singapore statement on research integrity**
  https://wcrif.org/guidance/singapore-statement
- **Contributor Covenant**
  A code of conduct for open source projects, with many well-known adopters
  https://www.contributor-covenant.org/
- **The DFG´s Code of Conduct of Safeguarding Good Research Practice**
  https://www.dfg.de/en/research_funding/principles_dfg_funding/good_scientific_practice/index.html
- **Netherlands code of conduct for research integrity**
  https://www.nwo.nl/en/policies/scientific+integrity+policy/netherlands+code+of+conduct+for+research+integrity
- **French National Charter for Research Integrity**
- **Universal ethical code for scientists**
  https://www.gov.uk/government/publications/universal-ethical-code-for-scientists
- **Statement of ethical principles / engineering ethics**
  Engineering Council and Royal Academy of Engineering
  https://www.raeng.org.uk/policy/supporting-the-profession/engineering-ethics-and-philosophy/ethics
  https://www.engc.org.uk/standards-guidance/guidance/statement-of-ethical-principles/
- **NSPE (National Society of Professional Engineers) – Code of Ethics for Engineers**
  https://www.nspe.org/resources/ethics/code-ethics
- **Fraunhofer Scientific Integrity**
  https://www.fraunhofer.de/en/about-fraunhofer/corporate-responsibility/research-and-development/scientific-integrity.html

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