Open Science

Research note

FEBRUARY 2021

Open access to scientific knowledge has become a priority for governments and funding bodies in recent years. France adopted a *Plan national pour la science ouverte* (*Open Science National Plan*) in 2018. The *Politique de diffusion en libre accès des Fonds de recherche du Québec* (*Open Access Dissemination Policy of Québec's Research Funding Agencies*) came into effect in 2019. The Canadian federal government released a *Roadmap for Open Science* in 2020 as part of its *National Action Plan on Open Government*.

But what does it actually mean, to open up science?

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COALITION PUBLICA

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What is open science?

As the Office québécois de la langue française (OQLF) indicates in its definition, open science is, first and foremost, a movement. Its members display a common will: "*amener, via le Web, plus de collaboration, de transparence et d'ouverture dans la réalisation de leurs pratiques scientifiques* [to bring, using the web, more collaboration, transparency and openness to their scientific practices]."[1] Open access is only one area of open science, but the former predates the latter as a mobilizing issue [see research note on open access].

Open science is often (re)presented as an umbrella term.

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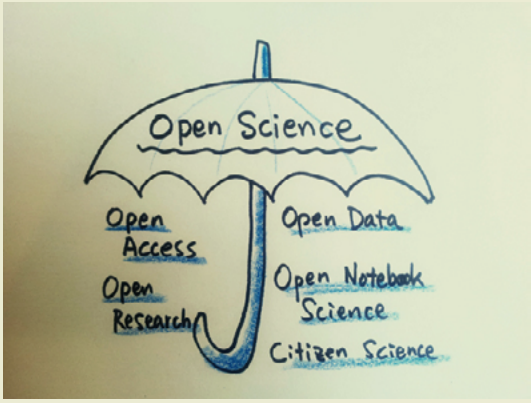

Figure 1: Open Science Umbrella. 11 octobre 2013. Photo. https://www.flickr.com/photos/100477638@N03/10204741904/.

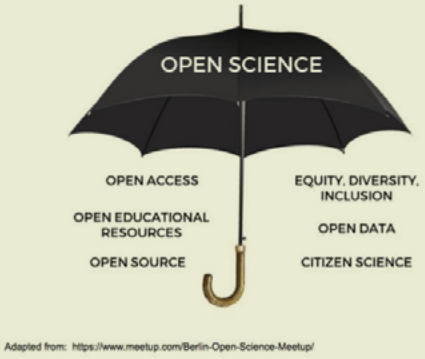

Figure 2: Champieux, Robin. "Rooting the Future of Open Research: Working for an Open Science University." Presented at OpenCon 2017, 20 November 2017, slide 12. slideshare.net/RightToResearch/rooting-the-future-of-open-research-working-for-an-open-science-university-robin-champieux.

[1] Office québécois de la langue française. "science ouverte." In *Grand Dictionnaire terminologique*. Québec: Office québécois de la langue française, 2014. granddictionnaire.com/ficheOqlf.aspx?Id_Fiche=26527562

The designation covers a wide range of practices often considered separately. To give structure to the category of open science and distinguish its areas of training, the project Facilitating Open Science in European Research (FOSTER) developed the following taxonomy in 2015.

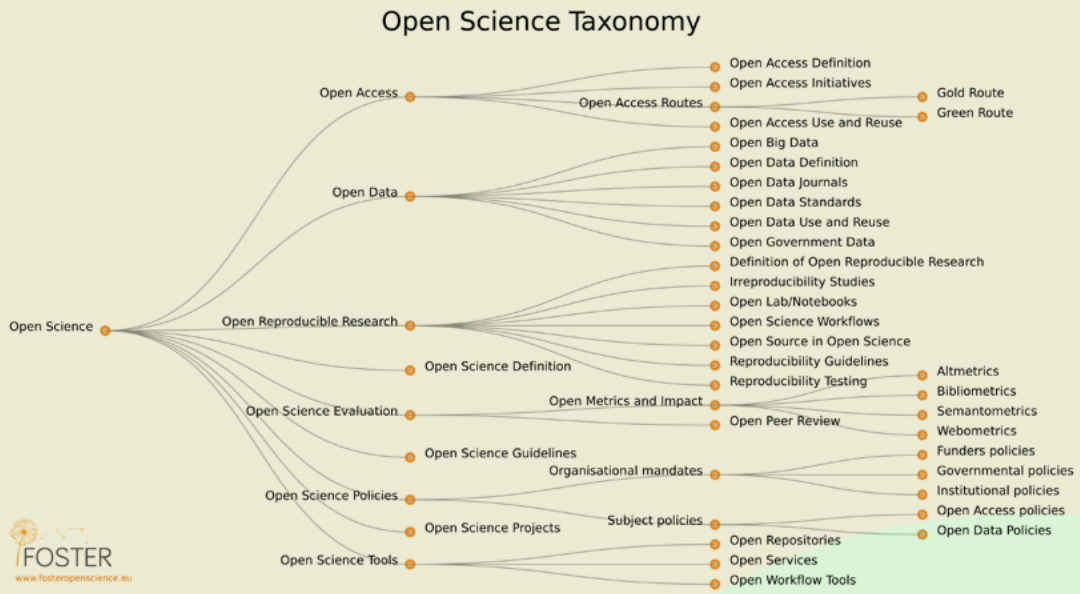

Figure 3: Open science taxonomy.

Source: Pontika, Nancy, Petr Knoth, Matteo Cancellieri, and Samuel Pearce. "Fostering Open Science to Research using a Taxonomy and an eLearning Portal." Graz, Austria, 2015. dx.doi.org/10.1145/2809563.2809571

The first of the highest tiers of the taxonomy are open access and open data, but the project is also concerned with open reproducible research and invites more thinking about open science evaluation.

After having developed its taxonomy, FOSTER came to the following definition:

> Open Science is the practice of science in such a way that others can collaborate and contribute, where research data, lab notes and other research processes are freely available, under terms that enable reuse, redistribution and reproduction of the research and its underlying data and methods.[2]

[2] Bezjak, Sonja, April Clyburne-Sherin, Philipp Conzett, Pedro Fernandes, Edit Görögh, Kerstin Helbig, Bianca Kramer, et al. *Open Science Training Handbook*, 2018. doi.org/10.5281/ZENODO.1212496

Why is there no agreement on what it means to open science?

The groups and individuals who practice and advocate for open science come at it from different starting points. In 2013, before FOSTER formalized the various branches of open science, German medical doctor Sönke Bartling and engineer Sascha Friesike identified five schools of thought that advocated for open science to realize five different goals:

- democratize knowledge (Democratic School);
- make sure research is accessible to citizens (Public School);
- make it more efficient (Infrastructure School);
- foster collaboration (Pragmatic School); or
- measure impact differently (Measurement School).[3]

[3] Fecher, Benedikt and Sascha Friesike. "Open Science: One Term, Five Schools of Thought." In *Opening Science: The Evolving Guide on How the Web Is Changing Research, Collaboration and Scholarly Publishing*, edited by Sönke Bartling and Sascha Friesike. Accessed January 19, 2020. openingscience.org/get-the-book/

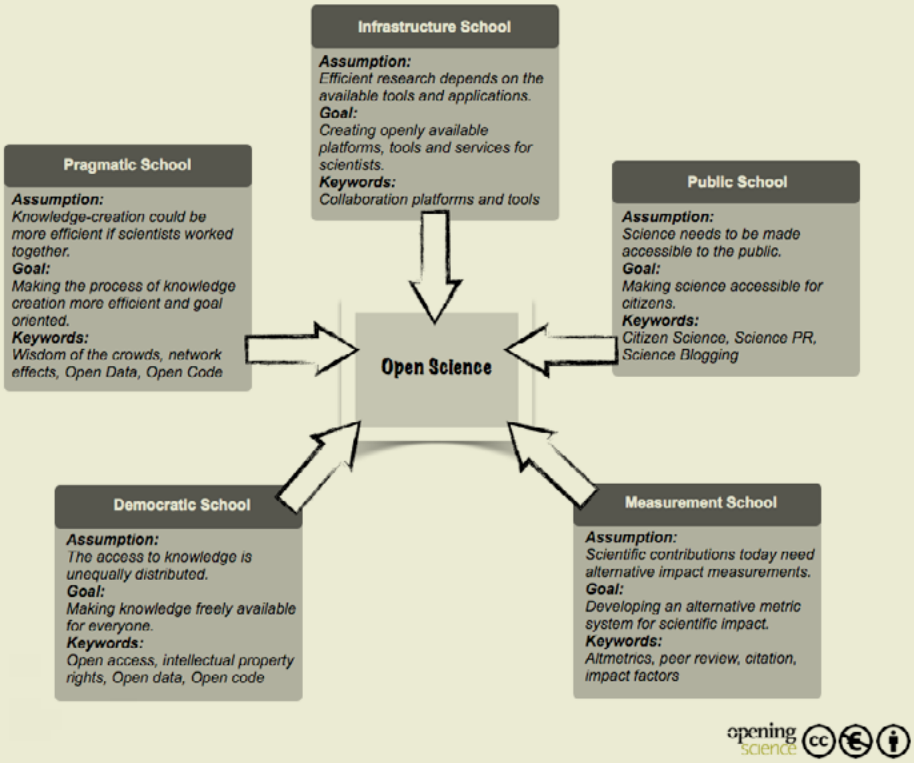

Illustration 4: The five schools of thought of open science.

Source: Fecher, Benedikt and Sascha Friesike. "Open Science: One Term, Five Schools of Thought." In Opening Science: The Evolving Guide on How the Web Is Changing Research, Collaboration and Scholarly Publishing, edited by Sönke Bartling and Sascha Friesike. Figure 10. Accessed 19 January 2020. http://www.openingscience.org/get-the-book/.

Examplifying how different goals can lead to the same outcomes, "Open Data" and "Open Code" are keywords both in the Pragmatic School, which sees them as a way to be more efficient, and in the Democratic School, which wants science to be accessible for free.

Just as open-science advocates may differ in their goals, they can differ in their definition of the adjective "open." For example, the French *Plan national* understands the open science movement as having more than one aim: "*construire un écosystème dans lequel la science sera plus cumulative, plus fortement étayée par des données, plus transparente, plus rapide et d'accès universel* [to build an ecosystem in which science will be more cumulative, more strongly supported by data, more transparent, quicker, and offering universal access]".[4]

[4] Ministère de l'Enseignement supérieur, de la Recherche et de l'Innovation. "Plan national pour la science ouverte," July 4, 2018, p. 3. https://cache.media.enseignementsup-recherche.gouv.fr/file/Actus/67/2/PLAN_NATIONAL_SCIENCE_OUVERTE_978672.pdf

Table 1: The five meanings ascribed to open science

FORM OF OPEN SCIENCE	MAIN ARGUMENT	KEYWORDS	READINGS
Open means transparent	Science, as practiced today, is not reproducible	• Open data • Open code • Open notebook science • Open peer review	McCullough (2009) Piwowar (2011) Fecher et al. (2014) Stodden (2009)
Open means collaborative	Science would be more efficient if more researchers would work more closely together and merge knowledge pools	• Polymath project • Collaborative writing	Gowers and Nielsen (2009) Cranshaw and Kittur (2011) Nielsen (2011)
Open means a broader understanding of impact	The method we currently use to determine the impact of research is insufficient and does not take advantage of web tools	• Altmetrics	Priem et al. (2010) Weller and Puschmann (2011) Weller (2014)
Open means open to the public	Science can benefit from including the general public into its workflows	• Science communication • Crowdfunding • Citizen science • Crowd science	Cribb and Sari (2010) Franzoni and Sauermann (2014) Hand (2010)
Open means accessible to anyone	Publicly funded research results should be publicly available (online)	• Open access	Rufai et al. (2011)

Source: Friesike, Sascha and Thomas Schildhauer. "Open Science: Many Good Resolutions, Very Few Incentives, Yet." In Incentives and Performance: Governance of Research Organizations, edited by Isabell M. Welpe, Jutta Wollersheim, Stefanie Ringelhan, and Margit Osterloh, 277-89. Cham: Springer International Publishing, 2015, p. 283 (Table 1). doi.org/10.1007/978-3-319-09785-5_17

Complete citations are provided on page 14.

The "openness" wished for in science can translate into greater transparency through open data, open-source software, open notebook science, and open peer review. This is the route advocated by Office of the Chief Science Advisor of Canada, as discussed below. This type of "openness" would foster scientific reproducibility beyond mere open access to publications.

What do governments make of open science?

Let's first look into the situation in Europe, the true world leader in open science.

Open science is actually a concept that was mainly formalized by the Europe Union in its funding programs, including its Framework Programmes for Research and Technological Development (abbreviated as Framework Programmes or FP). The sixth framework (FP6, 2002-2006) included a program called "Science *and* Society." In the next framework (FP7, 2007-2013), it was instead called "Science *in* Society."[5]

Since 2010, the European Union has sought to reconcile the aspirations and ambitions of its citizens with those of the research and innovation sector in a single concept: responsible research and innovation (RRI). It thus situates open science in an even large set of concerns that also encompasses the notions of citizen science, equity, diversity, and inclusion that are often associated with open science. The European Commission's Directorate-General for Research and Innovation has defined the six dimensions below of RRI.

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[5] Stilgoe, Jack. "Monitoring the Evolution and Benefits of Responsible Research and Innovation." Policy Brief, October 12, 2018, p. 2. ec.europa.eu/research/swafs/pdf/MoRRI_D8_Policy_brief.pdf. The most recent PCRD, Horizon 2020 (2014-2020), speaks of "Science *with and for* Society".

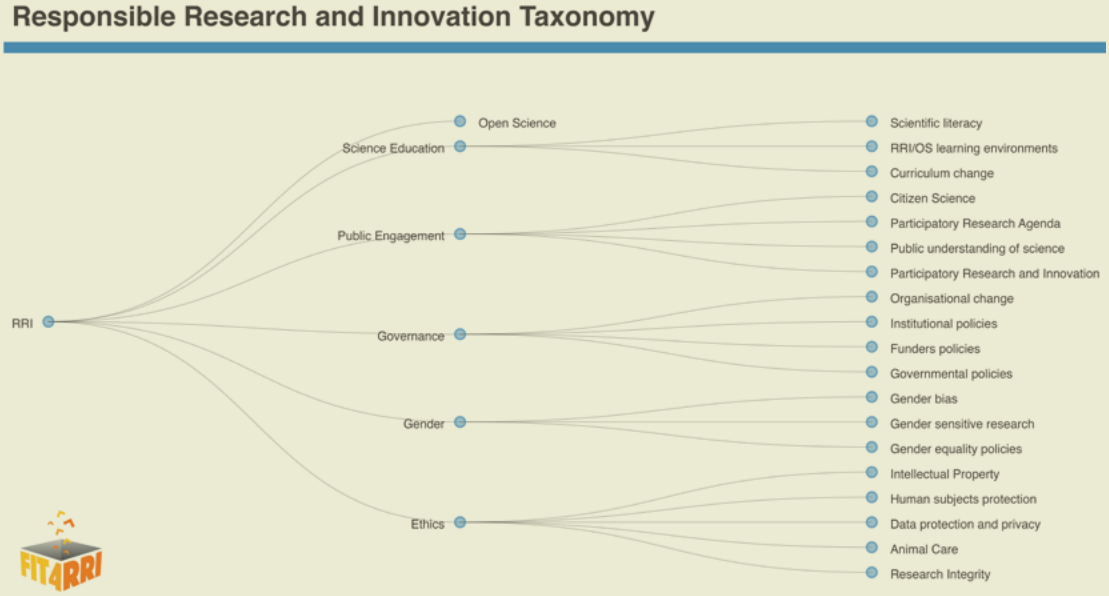

Illustration 5: Taxonomy of responsible research and innovation.

Source: FOSTER. "RRI." Accessed on 13 November 2020. fosteropenscience.eu/taxonomy/term/255

It was in 2014 that "open science" replaced "open access" as the name of one of these six dimensions, one example among many others that we are evolving from the notion of open access to the wider notion of open science.[6]

[6] European Union. *Responsible Research and Innovation: Europe's Ability to Respond to Societal Challenges*. Luxembourg: Directorate-General for Research and Innovation, 2012. ec.europa.eu/research/swafs/pdf/pub_public_engagement/responsible-research-and-innovation-leaflet_en.pdf; European Union. *Responsible Research and Innovation: Europe's Ability to Respond to Societal Challenges*. Directorate-General for Research and Innovation, 2014. ec.europa.eu/research/swafs/pdf/pub_rri/KI0214595ENC.pdf.

EUROPEAN COMMISSION: EIGHT AMBITIONS

The European Commission, for its part, maintains a very broad view of open science. This comprises eight "ambitions" that are more precise principles than the six dimensions listed above:[7]

- open data, i.e. Findable, Accessible, Interoperable and Re-usable (FAIR) data, a more precise definition of "open data" put forward in an article published in 2016; [8]
- the European Open Science Cloud (EOSC), launched in November 2018; [9]
- a new generation metrics [see the research note on impact measurement];
- the future of scholarly communication, including not only open access, but also open notebook science;
- rewards and therefore incentives to open science activities within the evaluation systems that determine research careers;
- research integrity;
- education and the skills required to integrate open science into research routines and practices;
- citizen science.

These European ambitions position open access as but one aspect of the future of scholarly communication and provide clearer mechanisms to achieving "open data". However, many national governments continue to conflate open science with open access to publications and data, as exemplified in France.

7 "Open Science Policy Platform Recommendations (OSPP-REC)." Luxembourg: Directorate-General for Research and Innovation, April 22, 2018. ec.europa.eu/research/openscience/pdf/integrated_advice_ospp_recommendations.pdf; European Commission. "Open Science." Factsheet, December 13, 2019. ec.europa.eu/info/files/open-science_en.

8 Wilkinson, Mark D., Michel Dumontier, IJsbrand Jan Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg, et al. "The FAIR Guiding Principles for Scientific Data Management and Stewardship." *Scientific Data 3*, no 1 (March 15, 2016): 1-9. https://doi.org/10.1038/sdata.2016.18.

9 European Commission. "Le nuage européen pour la science ouverte devient une réalité," November 23, 2018. https://ec.europa.eu/commission/news/european-open-science-cloud-becomes-reality-2018-nov-23_fr.

FRANCE: THREE AXES AND FOUR COLLEGES

In France, the *Plan national pour la science ouverte* adopted in 2018 defined open science as "*la diffusion sans entrave des publications et des données de la recherche* [the unobstructed dissemination of publications and research data]."[10] Its implementation involves three axes and four bodies called "colleges." The axes are:

1. to generalize open access to publications;
2. to organize and to open research data; and
3. to ensure the momentum it enjoys is sustainable, European and international. [11]

Each of the first two axes is associated with a college, and the third axis is overseen by two. [12] The *Compétences et formation* college (Skills and education) tackles sustainability by "*le développement de nouvelles pratiques quotidiennes pour les chercheurs* [developing new everyday practices for researchers]." [13] The *Plan national* suggests this goal can be met through online training and a certification for doctoral schools. The *Europe et international* college, finally, coordinates with supranational bodies.

10 Ministère de l'Enseignement supérieur, "Plan national pour la science ouverte." p. 3.

11 Ministère de l'Enseignement supérieur, "Plan national pour la science ouverte." p. 4, 6 et 8

12 Ouvrir la science. "Groupes." Accessed February 26, 2020. https://www.ouvrirlascience.fr/category/groupes/.

13 Ministère de l'Enseignement supérieur, "Plan national pour la science ouverte." p. 8.

Québec and Canadian Initiatives

FUNDING BODIES

In 2019, Québec's research funding agencies, the Fonds de recherche du Québec (FRQ), published an open access dissemination policy announced on their website under the heading "*Science ouverte* [Open science]".[14] At the federal level, the Social Sciences and Humanities Research Council of Canada (SSHRC) has had its own policy on open access since 2015: the *Tri-Agency Open Access Policy on Publications*.[15]

The provincial policy explicitly excludes from its scope "*les données utilisées [et] les données brutes produites par l'activité de recherche* [the data used and the raw data produced by the research activity]."[16] For their part, the federal funding bodies published a *Tri-Agency Statement of Principles on Digital Data Management*[17] in 2016 and are now preparing a final version of the *Tri-Agency Research Data Management Policy* following an online consultation in the summer of 2019.[18]

It is also worth noting that the International Development Research Centre (IDRC), a Crown corporation, has its own policies regarding open access and open data.[19]

14 Fonds Société et culture. "Science ouverte." Accessed January 19, 2020. http://www.frqsc.gouv.qc.ca/science-ouverte.

15 Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada. "Tri-Agency Open Access Policy on Publications," February 27, 2015. http://www.science.gc.ca/eic/site/063.nsf/eng/h_F6765465.html.

16 Scientifique en chef du Québec and Fonds de recherche du Québec. "Politique de diffusion en libre accès des Fonds de recherche du Québec," April 15, 2019, p. 2.

17 Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada. "Tri-Agency Statement of Principles on Digital Data Management - Science.Gc.Ca." Innovation, Science and Economic Development Canada, June 15, 2016. science.gc.ca/eic/site/063.nsf/eng/h_83F7624E.html

18 Government of Canada. "Research Data Management." Science.gc.ca. Innovation, Science and Economic Development Canada, December 9, 2019. science.gc.ca/eic/site/063.nsf/eng/h_547652FB.html; Canadian Institutes of Health Research, Natural Sciences and Engineering Research Council of Canada, and Social Sciences and Humanities Research Council of Canada. "Tri-Agency Research Data Management Policy: Draft for Consultation." Innovation, Science and Economic Development Canada, June 2018. science.gc.ca/eic/site/063.nsf/eng/h_97610.html.

19 International Development Research Centre. "Open Access Policy for IDRC-Funded Project Outputs," July 20, 2015. idrc.ca/en/open-access-policy-idrc-funded-project-outputs; International Development Research Centre. "Open Data Statement of Principles," November 20, 2018. idrc.ca/en/open-data-statement-principles

GOVERNMENT OF CANADA

Launched in February 2020, the objective of the Canadian government's *Roadmap for Open Science* is "to provide overarching principles and recommendations to guide Open Science activities in Canada" in an effort to ensure transparency, inclusiveness, collaboration, and sustainability.[20] Its all-encompassing definition targets three distinct elements, aiming to "mak[e] scientific inputs, outputs and processes freely available to all with minimal restrictions."[21] This roadmap seeks to enhance a number of different areas, including the reproducibility of scientific results; the accountability and public engagement; efficiency and effectiveness; innovation; and knowledge transfer. The roadmap therefore presents a series of ten recommendations touching upon open access, open research data, FAIR data principles, and the harmonization of existing policies.

With this roadmap, the Canadian government intends to increase access to the research outputs produced by federal scientists and contracted by federal departments and agencies, not to those of academics. One of the recommendations nonetheless concerns university research and identifies the need to develop an "Open Science strategy for federally funded research conducted outside of federal government agencies and departments" in the coming years.[22]

[20] Office of the Chief Science Advisor of Canada. "Roadmap for Open Science." Ottawa: Government of Canada, February 2020, p. 5. science.gc.ca/eic/site/063.nsf/eng/h_97992.html

[21] Office of the Chief Science Advisor of Canada. "Roadmap for Open Science," p. 11.

[22] Office of the Chief Science Advisor of Canada. "Roadmap for Open Science," p. 9.

What is the relationship between open science and open government?

The term "open government" was formalized earlier than open science thanks to the Open Government Partnership (OGP), a worldwide multilateral initiative launched in 2011 with the *Open Government Declaration*. Also rooted in the new possibilities afforded by the digital environment, this notion brings under the same roof goals similar to that of open science. The declaration contains four commitments for the governments that sign it:

- "Increase the availability of information about governmental activities";
- "Support civic participation";
- "Implement the highest standards of professional integrity throughout our administrations";
- "Increase access to new technologies for openness and accountability."[23]

In Canada, open science is one of the strategies through which the government seeks to become more open, along with financial transparency and accountability; digital government and services; and feminist and inclusive dialogue[24]. In prioritizing open science, *Canada's 2018-2020 National Action Plan on Open Government* focuses on internal, "intramural" research produced by its own scientists.[25]

In France, the relationship between open science and open government takes a different form, focusing on government spending transparency. The *Plan national* also aims to "*alimenter le débat public autour des résultats de la recherche* [stimulate public debate regarding research results]"by feeding them into Isidore, a service that harvests humanities and social science digital documents and data to make it easier to access them, and scanR, a database of research- and innovation-related government and private structures.[26]

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23 Open Government Partnership. "Open Government Declaration." Open Government Partnership, September 2011. opengovpartnership.org/process/joining-ogp/open-government-declaration/

24 "Canada's 2018-2020 National Action Plan on Open Government." Ottawa: Treasury Board of Canada Secretariat, 2018. deslibris.ca/ID/10099446

25 Akerman, Richard. "Open Science in Canada's 2018-2020 Open Government Plan." *Science Library Pad*, January 10, 2019. scilib.typepad.com/science_library_pad/2019/01/open-science-in-canadas-2018-2020-open-government-plan.html

26 Ministère de l'Enseignement supérieur, "Plan national pour la science ouverte." p. 9.

Success requires funding bodies buy-in

No matter how a government approaches open science, this priority must reach the funding bodies. Otherwise, as is the case with open access, without financial incentives for researchers to adopt open-science practices, progress will be too slow. As the European Commission's policies show, implementing open science is a complex process that involves more than simply making scientific knowledge more openly accessible. All agents involved in research can and should take part, but government support is especially crucial.

JOURNAL BEST PRACTICES

- Encourage your authors to publish their data using FAIR principles (Findable, Accessible, Interoperable and Re-usable)
- Ask your authors to sign *FRQSC's Politique sur la conduite responsable en recherche* (2014) or SSHRC's *Tri-Agency Framework: Responsible Conduct of Research* (2016)
- Accept articles even if the process has been documented along the road in an open notebook (e.g. OpenEdition's Hypotheses platform)
- Develop peer-reviewing practices that are adapted to citizen science
- Consider adopting some or all of the principles of open peer-review

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