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Developing a Toolkit for Fostering Open Science Practices: Proceedings of a Workshop (2021)

DETAILS

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CONTRIBUTORS

Thomas Arrison, Jennifer Saunders, and Emi Kameyama, Rapporteurs; Committee on Developing a Toolkit for Fostering Open Science Practices: A Workshop; Board on Research Data and Information; Policy and Global Affairs; National Academies of Sciences, Engineering, and Medicine

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Appendix C

Toolkit Elements

This appendix includes examples of draft elements of a toolkit that have been developed by members of working groups of the National Academies of Sciences, Engineering, and Medicine’s Roundtable on Aligning Incentives for Open Science. The following materials were developed to stimulate discussions at the November 5, 2020, workshop on Developing a Toolkit for Fostering Open Science Practices:

- I. **Open Science Imperative.** This essay communicates the benefits of open science using approachable language.
- II. **Open Science Signaling Language Template and Rubric.** These resources provide specific language that can be adapted and adopted to signal an organization’s interest in open science activities at specific points of high leverage (e.g., grant applications, job postings).
- III. **Good Practices Primers.** These concise guides offer policy makers a high-level overview of open sharing.
- IV. **Open Science by the Numbers Infographic.** This infographic communicates the benefits of open science in a graphic form.
- V. **Open Science Success Stories Database.** This database compiles research articles, perspectives, case studies, news stories, and other materials that demonstrate the myriad ways in which open science benefits researchers and society alike.

- VI. **Reimagining Outputs Worksheet.** This table enumerates the range of research products stakeholders may choose to consider as they develop open science policies.

The toolkit is primarily intended to assist university leadership, academic department chairs, research funders, learned societies, and government agencies about how such a toolkit might be used, what additional materials are needed, and how such a toolkit should be disseminated for broad adoption. As a result of the workshop, a few sections in the Open Science Imperative and Good Practices Primers have been revised by the working group authors.

VI. REIMAGINING OUTPUTS WORKSHEET⁴⁰

Boyana Konforti, Formerly, Howard Hughes Medical Institute

Elizabeth Albro, U.S. Department of Education

Anurupa Dev, Association of American Medical Colleges

Josh Greenberg, Alfred P. Sloan Foundation

Ross Mounce, Arcadia Fund

Brian Quinn, Robert Wood Johnson Foundation

Greg Tananbaum, Open Research Funders Group

Richard Wilder, Coalition for Epidemic Preparedness Innovations

The following table (organized alphabetically) represents the authors' perspective about the range of research products that should be accounted for as the science community thinks about the behaviors and activities that should be rewarded. What are the outputs that are consistent with the values the science community collectively espouses? What outputs encourage open dialog and the tackling of big questions, build upon and enhance the work of others, and advance the research endeavor? As the community enumerates these research products, what considerations must be contemplated and addressed to create appropriate alignment between values and activities? The authors believe it will be crucial to ensure that the science community takes an expansive view of the types of research products that should be "open"—available for access and reuse without gatekeeping or payment.

⁴⁰The views expressed are those of the authors and do not necessarily reflect the official policies or positions of their employing organizations.

Reimagining Outputs Worksheet Table

Research Output Type	Exemplar Open Practices	Importance to Open Ecosystem	Concerns/Considerations
Articles	All primary research articles should be made immediately available (open access with no embargo period) and reusable via an expansive license such as CC BY.	Unrestricted access to, and reuse of, published articles benefit the research community by facilitating the discovery of new information, thus maximizing opportunities for that work to lead to new insights and discoveries.	<ul style="list-style-type: none"> Free to read is often the primary focus of open access policies, but reuse considerations (including, but not limited to, text and data mining) also merit consideration. Distinctions between versions (version-of-record accepted manuscript) may be more important within certain disciplines. Stewardship/ownership of repositories—ensuring these are open and sustainable.
Code and Software	To the greatest extent allowable by copyright, all software, code, lab notebooks, and executables necessary to independently verify research results should be curated and made freely available in an open repository no later than the publication of the first paper running this code.	The independent confirmation of results and conclusions is critical for understanding scientific soundness and informing future research activities. To extract maximum value from research findings, both the raw data that underpin the results and any code deployed to process these data must be widely and freely available to any interested party. Succinctly, research findings are not fully open unless the tools necessary to understand and test them are also made available.	

<p>Commentaries and Analyses</p>	<p>Commentaries, analyses, and other summary works that place research developments into context should be made immediately available (open access with no embargo period) and reusable via an expansive license such as CC BY.</p>	<p>With millions of research articles published annually, the need for filtering, selection, and curation has never been greater. Commentaries and analyses, including (but not limited to) review articles and research summaries, provide context for the findings described in primary articles. These materials extend the utility of primary research and widen the prospective audience to include policy makers and the general public.</p>	<ul style="list-style-type: none"> • Commentaries and summaries are an important way for learned societies to add value and continue to earn some subscription income.
<p>Data</p>	<p>Subject to personal privacy, regulatory, and legal restrictions, data underlying specific claims in a research project should be deposited with the necessary metadata into a repository, with efforts taken to maximize findability, accessibility, interoperability, and reuse. Deposits should be made no later than the publication of the first paper based on the data. Data should be considered legitimate, citable products of research.</p>	<p>The independent confirmation of results and conclusions is critical for understanding scientific soundness and informing future research activities. Openly shared data can shed light on negative results and attempted research directions, with the potential to improve efficiency of the research process as well as lead to novel analyses and conclusions.</p>	<ul style="list-style-type: none"> • Stewardship/ownership of repositories—ensuring these are open and sustainable. • Timing of data release. • Restrictions on data reuse (e.g., text and data mining).

continued

Table Continued

Research Output Type	Exemplar Open Practices	Importance to Open Ecosystem	Concerns/Considerations
Digital Scholarship	Multimedia, digital media, and audiovisual outputs should be made immediately available (open access with no embargo period) and reusable via an expansive license such as CC BY.	Digital scholarship encompasses a range of research outputs in several disciplines (particularly in the humanities). These materials are critical to the scholarly record, particularly when they are made available under a license that permits reuse and remixing.	<ul style="list-style-type: none"> Stewardship/ownership of repositories—ensuring these are open and sustainable. Ensuring that materials are “future proofed” and viable for access and reuse for an extended period of time.
Monographs, Books, Book Chapters, and/or Edited Volumes	All monographs, books, book chapters, and/or edited volumes should be made immediately available (open access with no embargo period) and reusable via an expansive license such as CC BY.	Unrestricted access to, and reuse of, monographs, books, book chapters, and/or edited volumes benefits the research community because it facilitates the discovery of new information, and thus maximizes opportunities for that work to lead to new insights and discoveries.	<ul style="list-style-type: none"> Open access for books and longer form content is less developed than journals. Few options/models.
Non-Peer-Reviewed Reports, Posters, and Presentations	All non-peer-reviewed outputs that are appropriate to be shared with the research community (e.g., reports and presentations) should be made immediately available (open access with no embargo period) and reusable via an expansive license such as CC BY.	Unrestricted access to, and reuse of, non-peer-reviewed outputs benefits the research community because it facilitates the discovery of new information, and thus maximizes opportunities for that work to lead to new insights and discoveries.	<ul style="list-style-type: none"> Grantees/faculty members may require additional guidance as to what constitutes an appropriate research output.

Peer Reviews

Peer reviews should be published with the article (so-called open reports). They can be anonymous or not. The author's response to the reviews should be published as well.

Publishing referee reports makes the process more transparent. Peer reviews contain arguments and ideas that can reveal how thinking in a field evolves. This material should be preserved and made available to others. Additionally, readers have a right to understand the level of scrutiny that a paper has undergone, and it provides them with a window into the editorial process. Because peer reviews are an essential component of the research endeavor, publishing referee reports helps create a pathway for formally crediting this activity.

- Infrastructure limitations. Right now, less than 3 percent of scientific journals allow peer reviews to be published.
- Ownership considerations. Who has the right to disseminate referee reports? Authors? Reviewers? Publishers?
- Providing credit for peer reviews without compromising anonymity (see ORCID *PLOS*⁶ collaboration).
- Several initiatives are emerging to support peer-review experiments. For example, ASAPbio has launched ReimagineReview a directory of peer-review trials, inside and outside the journal system.⁶

continued

Table Continued

Research Output Type	Exemplar Open Practices	Importance to Open Ecosystem	Concerns/Considerations
Preprints	<p>Scientists should share preprints (paper drafts that have not yet been peer reviewed for formal publication) by posting in a repository or preprint server that codifies free, unrestricted, and perpetual access to the preprint. Preprints should be posted in a timely manner, ideally at the time of first submission to a journal.</p>	<p>Preprints allow research findings to be quickly and easily available to all and allows researchers to claim priority of discovery, receive community input, and demonstrate evidence of progress for funders and others.</p>	<ul style="list-style-type: none"> • The growing visibility of preprints may render double-blind peer review more challenging, as prospective referees are exposed to preprints (and their authors) prior to the journal submission and review stages. • Several initiatives are emerging to support preprints. For example, ASAPbio.org is a comprehensive resource for information on preprints, peer reviews, transparency, and so forth.^c Transpose is a directory of journal policies, co-reviewing, and preprints.^d

<p>Preregistration Analysis Plans</p>	<p>Indicate in grant proposals, progress reports, and published articles of funded research that the research will be preregistered with an analysis plan. Provide a URL link to preregistration in reports and articles when completed. When results are reported, make a clear distinction between the planned research and any unplanned research or analysis that was conducted. Disclose any deviations from the planned procedures.</p>	<p>Unreported flexibility in data analysis decreases scientific credibility and invalidates common tools of statistical inference. By submitting a detailed study protocol and statistical analysis plan to a registry prior to conducting the work (i.e., preregistering with an analysis plan) the scientist makes a clearer distinction between planned hypothesis tests (i.e., confirmatory tests) and unplanned discovery research (i.e., screening or exploratory research). Preregistration is particularly important for studies that make an inferential claim from a sampled group or population, as well as studies that are reporting hypotheses.</p>	<ul style="list-style-type: none"> • May not be appropriate for all types of research, such as studies that do not claim to make inferences, that are purely discovery, that do not test hypotheses, or that generate computational models. • Also see the Registered Reports section, below, as a way to practice prospective registration.
<p>Protocols</p>	<p>Descriptions of the design and implementation of experiments should be made freely available in an open repository that facilitates the sharing, editing, forking (copying and adopting/modifying), and further development. These include study protocols (description of the study plan), and laboratory protocols (detailed description of experimental methods).</p>	<p>Understanding the starting point for work—including assumptions—along with the final study and analysis can provide guidance to other researchers as to additional research avenues to explore. Protocols provide the context to interpret and understand how research results are derived. They can convey exactly what was done and the decisions/compromises that were made en route to a scientific discovery.</p>	<ul style="list-style-type: none"> • Protocols can be shared prior to conducting work, which provides insights into research that does not ultimately get published; this is uncommon at present.

continued

Table Continued

Research Output Type	Exemplar Open Practices	Importance to Open Ecosystem	Concerns/Considerations
Registered Reports	<p>Indicate in grant proposals, progress reports, and published articles which parts of the funded research will be submitted as a registered report. In project time-line documentation, add the appropriate time (e.g., 2 to 4 months) for the peer-review process at the beginning of the relevant project phases. Communicate with the funder on any procedural changes that occur as a result of peer-review feedback. If the funder partners with journals to combine reviewer feedback to jointly offer funding and publishing, submit to such solicitations.</p>	<p>Peer review of study protocols with analysis plans, along with dissemination of findings regardless of outcome, addresses publication bias against null results. It also provides the benefits of preregistration by making a clearer distinction between hypothesis tests and discovery research. By submitting funded studies to journals as a registered report, the scientist improves study planning, increases study rigor, and improves scientific credibility. Funders who support this process anticipate that peer-review feedback could change study processes that result in budget changes and are prepared to consider such amendments in response to journal reviewer feedback. Funders can also partner with journals to coordinate review for funding and publishing decisions.</p>	<ul style="list-style-type: none"> • In some disciplines and in some types of research, infrastructure (including, but not limited to, participating journals) to support registered reports activities is limited. • May not be appropriate for all types of research, such as studies that do not claim to make inferences, that are purely discovery, that do not test hypotheses, or that generate computational models.

<p>Research Materials</p>	<p>Biological and other physical samples (in particular starting materials), research tools (including reagents, animal models, and the like), and other materials (including metadata and identifiers) necessary to reproduce or extend research findings should be made freely available in an open repository no later than the publication of the first paper based on the materials.</p>	<p>Similar to code and data, it allows the independent confirmation of results. Also similar to code and data, broader access to research materials can accelerate research more broadly and allow comparisons across research project or products. Biological materials, such as cell lines, are fundamentally different from data and even software as they may embody a type of “machine” that, through cell expression and the like, can be used to make desirable products, such as a particular valuable protein.</p>	<ul style="list-style-type: none"> • Cost of maintaining/sharing certain types of samples and quality control. • Stewardship/ownership of repositories—ensuring these are open and sustainable, including detailed descriptions of samples.
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Table Continued

Research Output Type	Exemplar Open Practices	Importance to Open Ecosystem	Concerns/Considerations
Theses and Dissertations	All theses and dissertations should be made available (open access with as short an embargo period as possible) and reusable via an expansive license such as CC BY.	Theses and dissertations represent significant contributions to the advancement of knowledge and the scholarly record. The open sharing of these materials offers a particularly unique insight into the research perspective of the emerging generation of scholars.	<ul style="list-style-type: none"> • Because students often try to publish portions of their theses and dissertations as articles, and because some journals still consider posted electronic theses/dissertations to be “prior publication,” a reasonable embargo period may be both necessary and appropriate. • An embargo of substantial length may create an added burden if the author has graduated and left the institution. • Authors of theses and dissertations that disclose a novel process or invention for which a patent may be sought may require longer embargoes. • Some theses and dissertations incorporate works of other copyright owners; this may require additional intellectual property guidance.

^a See <https://theplosblog.plos.org/2019/06/youve-completed-your-review-now-get-credit-with-orcid>.

^b See <https://reimaginerreview.asapbio.org>.

^c See <https://asapbio.org>.

^d See <https://transpose-publishing.github.io/#>.

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