IAP input into the UNESCO Open Science Recommendation

Submitted to UNESCO 16 June 2020

Background

Under the umbrella of the InterAcademy Partnership (IAP, www.interacademies.org), 140 national, regional and global member academies work together to support the vital role of science in seeking evidence-based solutions to the world's most challenging problems. IAP harnesses the expertise of the world's leading scientific minds to advance sound policies, improve public health, promote excellence in science education, and achieve other critical development goals. Our academy members constitute more than 30,000 leading scientists, engineers and health professionals in over 100 countries.

During the 40th UNESCO General Conference in November 2019, UNESCO's 193 Member States requested that UNESCO lead a global consultation on Open Science to develop globally-agreed norms and standards in the form of a UNESCO Recommendation on Open Science. As part of the consultation process, UNESCO requested IAP and other science organizations to contribute input to inform the Recommendation. IAP and its member academies, along with many other stakeholders, were also invited to complete a questionnaire about Open Science principles and the benefits and challenges of Open Science around the world. For more details about the UNESCO Recommendation, please see: https://en.unesco.org/news/unesco-launches-global-consultation-develop-standard-setting-instrument-open-science.

To prepare this document to inform UNESCO's development of the Open Science Recommendation from the perspective of our global network of academies, IAP members nominated experts to constitute an international working group. The text presented below has thus been developed by the 10 members of this ad hoc working group (details below) on behalf of IAP. The text also draws on and references responses to the UNESCO questionnaire for inputs into the development of the Open Science Recommendation that were submitted by individual member academies as noted.

Preface

This text discusses Open Science primarily from a researcher's perspective. We recognize that the topic of Open Science can be analyzed through multiple lenses, not only of those directly involved in the production of science, but also its enablers, facilitators and beneficiaries. Though research often involves physical objects (e.g., samples or books on paper), current major discussions on open science outputs are restricted to the digital world, and their preparation, sharing, storage, preservation and dissemination via computational infrastructures.

1. Introduction

Open Science *is the foundation of global scientific collaboration*, and as such needs to be conducted under the principles of trust, equity, transparency and responsible research conduct at a global scale. It is an enabler of collaboration without borders. It involves both *human values* and *technological considerations*. The practice of open science serves as a catalyst for the *significant cultural changes* that are required for the effective conduct of global scientific research.

This collaboration is achieved and facilitated by sharing the outputs of research, which should be open and freely accessible. Sharing is performed either directly – by accessing and reusing the outputs, or indirectly – when reuse adapts these outputs to produce knowledge in domains not imagined by those who produced them, maybe even decades later. Global collaborators come from many cultures, speak thousands of languages and live and work under a wide variety of administrative, legal and financial frameworks. In the open science ecosystem, science knows no borders – geographical, temporal, social or cultural.

Being primarily concerned with collaboration, open science faces all the challenges and benefits of conducting research collaboratively. Such collaboration can be fostered by appropriate education, incentives, policies, financing mechanisms, training and infrastructure, among others. Its challenges and benefits are magnified by the scale at which collaboration is conducted in the open science ecosystem. In this context, the unique aspects of openness play a major role in that researchers cannot always predict with whom they will collaborate, and to who (and whose research and how) they are contributing. As such, in making their scientific outputs publicly available, researchers need to ensure that these outputs can be adopted and (re)used by experts from distinct domains, working under different views of the world, and for purposes other than the ones for which these outputs were originally produced.

What are, then, these Open Science outputs through which global collaboration is facilitated? The most common goal of open science is to ensure the free availability and usability of all digital outputs of research and related objects, including "scholarly publications, the (raw) data resulting from scholarly research, and the methodologies, which includes code or algorithms that were used to generate those data” (NASEM, 2018). It concerns “making all activities performed throughout the research life cycle openly available to whoever might need them to further advance science. It strengthens the visibility of research, innovation and creation, maximizing their impact and retribution to society”, (Declaración de Panamá, 2018).

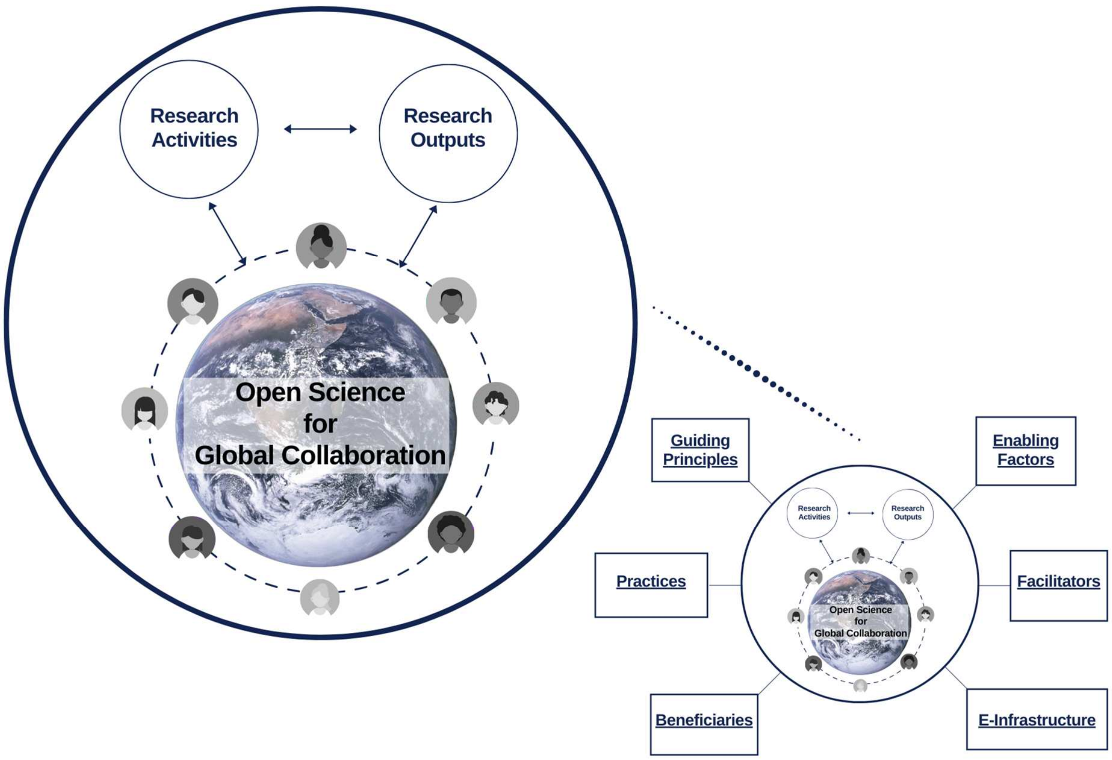

Figure 1 - Researchers, research activities and research outputs in a virtuous circle towards Open Science for Global Collaboration. Researchers are the central actors in this view.

Figure 1 shows researchers working together across time and geographical space, and how, through their research activities, they generate research outputs thereby helping to construct and consolidate the Open Science Ecosystem. Collaboration is enhanced via the outputs, which in turn are improved through participation of a wider group of researchers (and domains). Outputs in turn influence the way activities are conducted, the whole cycle receiving feedback and acting on it to generate yet more knowledge. This is a virtuous cycle in which better science is achieved by involving more voices and perspectives.

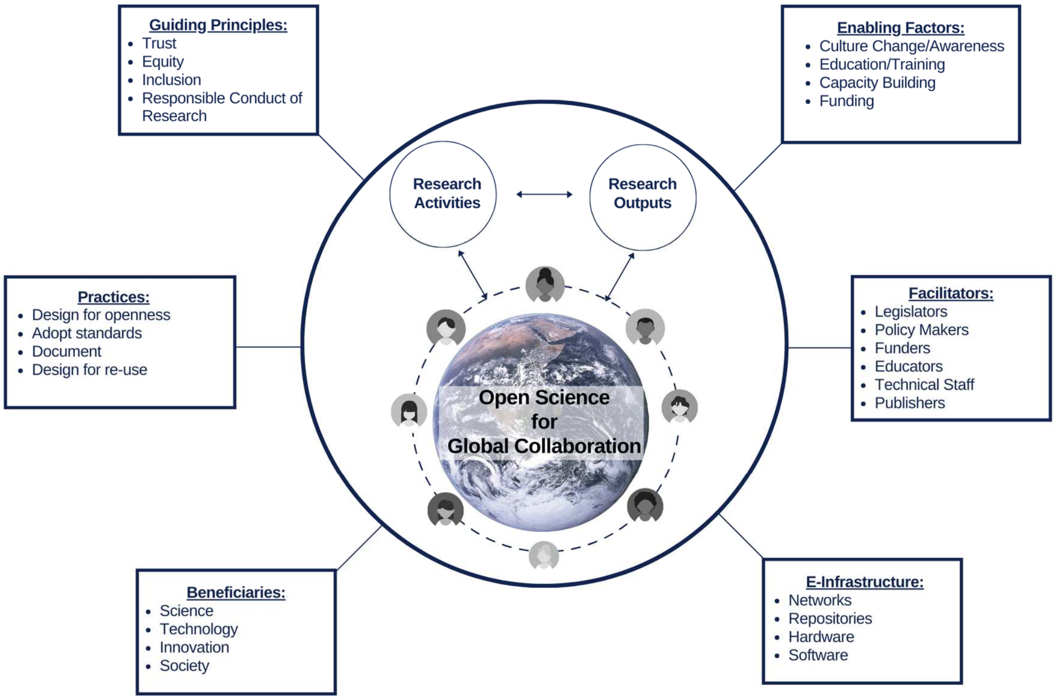

Figure 2 - Ecosystem of Open Science for Global Collaboration among researchers around the world. Researchers engage in research activities and provide research outputs in a virtuous cycle.

Figure 2 details the main elements of this perspective of the Open Science Ecosystem as an enabler of global collaboration without barriers, conducted under the guiding principles of Trust, Equity, Inclusion and Responsible Research Conduct. Several factors must be considered to effect this vision. It requires an appropriate E-infrastructure, including hardware, software, repositories for sharing the outputs, and high-speed internet with broadband connection (e.g., to allow transfer of big data). Funding is a key Enabling Factor, but funding alone is not enough: open science demands, above all, education and capacity building of all involved, promoting culture change and awareness of the opportunities and challenges of producing knowledge in this context. It cannot be conducted without a myriad of Facilitators, who are not researchers themselves, but who play fundamental roles in making this ecosystem work. It requires adopting Best Practices, conducting research activities and preparing outputs for sharing without borders. Last but not least, the Beneficiaries of this global collaboration are not only science itself, but also technology, innovation and ultimately society.

Figure 2 also conveys the idea that Open Science needs to be understood and assessed as part of a broader perspective on the relationship between science and society, fostering the advancement of knowledge and increasing its impact on society. Ultimately, Open Science mobilizes knowledge generated through science, innovation and technology to reach society with a clear impact on the generation of public policy, the educational system and the common citizen (Declaración de Panamá, 2018).

It should be practiced under ethical principles, and take into account issues such as privacy, intellectual property, and legal frameworks. Its outputs should be made “as open as possible, as closed as necessary”.

In more detail, an e-infrastructure (also ‘ICT infrastructure’ or ‘cyberinfrastructure’) in this context encompasses all the devices, networks and middleware that are employed to support distributed research computing. It refers to the building of a user environment to run systems, which then provide users with the required functionalities.

There are multiple societal actors in Open Science; each of them has a role to play, and responsibilities associated with that role, to further openness in science and equitable collaboration. Researchers are at the centre of open science activities. From the very beginning of the research process, they both contribute to and take advantage of the open science practices of other members of the research community. Leaders at research institutions are key to developing a supportive structure and reward system for open science practices. Educators, including university faculty, experts in the ethical conduct of science, members of professional societies, and innovators in the private sector, all have a role to play in the training related to open science principles and practices, and in educating all actors about open collaboration at all levels. Information scientists, including librarians and computer scientists, play a role in developing tools for open science practices and for ensuring that the products of research are appropriately stewarded and preserved for future use. Legal scholars provide the basis for the legal protections of open science practices. Publishers, editors and leaders of professional societies, have a role to play in designing methods for transitioning from current publication models to those that support open science. Technical staff ensure the appropriate functioning of the e-infrastructure, so that production and dissemination of outputs can be achieved. Research funders provide the necessary resources for the broad range of open science practices. Policy makers provide the policy foundation for changes in the practice of science. Users of open research are the ultimate beneficiaries of open science practices – either active actors who will profit from this global environment to develop better research, infrastructure and policies, or society as a whole, which will benefit from the outputs of the Open Science movement.

2. Guiding principles for Open Science Practices and Implementation

Open science should be guided by the “principles of inclusion, fairness, equity and sharing, and ultimately seek to change the way research is done, who is involved and how it is valued" (Bezjak et al, 2018). It can only prosper in an environment in which there is trust. It must ensure that the outputs of publicly funded scientific research are treated as a public good and thus both created and managed as such. Education for openness must guide the construction of an open science ecosystem.

Open science practices require a culture change from all actors, so that research (and its enablement) is conducted with global collaboration in mind. As such, another set of principles refer to what has been called "open science by design" (NASEM, 2018) and involve both a scientist's mindset and the technical details of an experiment. Some of its key elements appear under "Practices" in Figure 2. Through "open science by design", researchers (and, indeed, all participating actors) work with the explicit intention of sharing with the world the outputs of their research, which is conducted aiming at openness.

From a technological viewpoint, researchers must configure their outputs with global sharing in mind (namely, according to consensual standards, adequate documentation, appropriate metadata and digital preservation measures), having reuse and reproducibility in mind. Thus, open science practices should be conducted under the so-called FAIR principles - they must be Findable, Accessible, Interoperable and Reusable (Wilkinson et al., 2006). Moreover, "all phases of the research process provide opportunities for assessing and improving the reliability and efficacy of scientific research" (NASEM, 2018: 4, 107).

Thus, researchers need to explore open research resources and use open tools to network with colleagues, developing and revising research plans for preparing and sharing research outputs under FAIR principles. They should collect data, use tools compatible with open sharing, and use automated tools to ensure accessibility of research outputs. In the dissemination phase, researchers should ensure that they use appropriate licenses for sharing their research outputs, depositing them in FAIR repositories so that these outputs are accessible and reusable over the long-term. Sharing for global collaboration must also consider that the shared objects might be (re)used beyond their original intent – for example, historians may need environmental data, clinical studies may reuse socio-economic data and associated articles, and so might biodiversity studies. Software developed for simulation problems can be adapted and reused in other scientific contexts.

At another, basic, technological level, appropriate infrastructure for global collaboration is needed. Not only does this mean that all scientists must have access to appropriate hardware, software, repositories and networks, but also that this infrastructure must be conceived and designed with sharing in mind, e.g., interoperable tools or adequate licensing of publications, software or data.

3. Challenges of Open Science

Being concerned with global collaboration, open science challenges are those that already exist in fostering collaborative environments (including *incentives/disincentives, infrastructure & capacity needs, financial considerations*), to which we add those of needing to be "open to the world". We distinguish between challenges that involve human values – culture change and adaptation through education – and those that consider technical issues – and thus require training, and appropriate e-infrastructure.

Practices and policies need to ensure inclusive participation, promote equitable collaboration and cognitive justice, and take into account disparities in science levels and capacities at the regional and global level. Traditional scientific ethical procedures and protocols need to be reengineered and expanded to consider the benefits (and risks) of openness.

Ensuring trust is a guiding principle; gaining it is a major challenge. This involves, among other considerations, creating environments in which scientific outputs can be adopted and reused while ensuring their security and integrity, to avoid their destruction or misuse (including preventing or counteracting dual use). Another major issue is how to surmount "difficulties to assure reliability and transparency between partners, institutions and academies" (Argentina Academy of Medicine questionnaire response).

Practicing open science often requires changing research practices and methodology, and even mindset – and thus additional effort from researchers, who do not necessarily understand the advantages of such an ecosystem. "The real obstacle comes from the researchers' feeling that it is not beneficial for their careers" (French Academy of Sciences questionnaire response). This is a double challenge – overcoming *perceptions* and i*ncentivizing* those who are willing to make the effort to change their practices and methodologies to work in an open science environment and contribute to its ecosystem.

Incentives and perceptions often go together. For instance, publications in prestigious journals are the most widely accepted means for career advancement – even being adopted by many national academies as recognition of scientific merit when electing their fellows. Having this in mind, most researchers concentrate all their efforts in publications. While these are an extremely important means for the dissemination of knowledge, research assessment and incentives have to extend their recognition to open science practices as a whole, to foster the open science ecosystem. Examples include public acknowledgement of such efforts, materializing this recognition into awards, or into inclusion in tenure and promotion criteria in academia, or by equivalent mechanisms for those who conduct research in non-academic environments, such as industries. By the same token, national academies and scientific societies should acknowledge open science practices and outputs in their awards and mechanisms.

Incentives go a long way towards culture change. In a more durable way, perceptions may be overcome by education, preparing people for working, studying, conducting research, and overall taking advantage of the benefits of the Open Science movement, in a multidisciplinary, multicultural context. Education efforts should start with *raising awareness*. Researchers have only limited knowledge about and experience with Open Science, including its ethical, security and privacy issues, and understanding the meaning of open publications, open data or open software. A first step is to raise awareness of the different components of Open Science and to actively promote its benefits and guide researchers to existing tools and methodologies. Education should also consider the differences among research domain practices, and also among regions, countries, and sometimes even within the same institution. We must "overcome digital heterogeneity in terms of internet literacy, connectivity and digital proficiency in the developing countries . . . triggering further innovative but culturally sensitive solutions to local sustainable development issues" (Pakistan Academy of Sciences questionnaire response).

At the technological level, challenges can be physical (e.g., inappropriate e-infrastructure), administrative (e.g., requiring reorganization of services within and across institutions and regions), skills-related (e.g., through lack of training opportunities for scholars and technical staff), legal (e.g. demanding the establishment of legal frameworks to account for licenses, intellectual property and such), or funding-related. All such challenges are magnified by financial, social or cultural inequalities posed by the global collaboration scenario (e.g., gender, age/seniority, region, institution).

Inappropriate e-infrastructures hinder communication, sharing and preservation, e.g., due to absence of connectivity, unreliable power supply, old equipment, or lack of security. For example, "we need not only high-speed internet in major cities but also in the rural areas. Also data repository equipment is needed to be enhanced throughout the country" (Pakistan Academy of Sciences questionnaire response). E-infrastructure should support the sharing of a wide spectrum of resources including hardware systems, secure computing environments, cloud systems connected by large bandwidth networks, hosting software systems that enable data analysis and providing access to massive data collections. It should also provide good performance and reliable data transfer services, identity management, and access control services. This requires "open inter-operational repositories, in an advanced network with connectivity to Latin American, transoceanic advanced networks, [and] sufficient storage capacity. Repositories should be interoperable, redundant, public, [and] without access restrictions" (Colombian Academy of Exact, Physical and Natural Sciences questionnaire response).

In addition, human resources should be provided to assist and train scientists to make the best use of technological assets, and acquire the necessary computing skills, for instance in data science, algorithms or networks. Curation of data or designing and developing open scientific software require considerable efforts and specific skills. The lack of expertise in computing skills, such as data science or software engineering, is a problem worldwide, especially in Africa. Although training institutions are trying to mitigate the need for such specialists through courses, they are unable to meet the increasing demand for such specialized personnel. The most popular scientific tools and software libraries are developed not only by a single individual or a research team, but by communities that might have hundreds of contributors. Maintaining and developing such tools, however, takes a lot of time and resources. Such valuable "communal" work should be acknowledged by the scientific community.

Issues relating to finance must be addressed if the cause of open science is to progress. Financing for research has always been a barrier; in the global scenario, this is exacerbated by regional disparities, hampering appropriate implementation of open science. Open access to publications, while offering everyone the possibility to read articles without paying, has at the same time imposed a barrier to researchers in low- and middle-income countries (LMICs), who cannot afford the cost of open publishing, given the open access conditions established by a large number of journals. Though mechanisms have been established in some regions through which public funding finances open access journals, "more than 70% of scientific publishing has become a commercial issue, which leads [to] publishers transforming themselves into open science to keep their profits with a consequent increase in budgets. It is essential to develop competitive access, namely 'bibliodiversity'" (French Academy of Sciences questionnaire response). The challenge is therefore twofold: on the one hand, to avoid that 'gold' open access reinforces the dominant position of large international publishers, which continue to intercept the budgets dedicated to publications; on the other hand, to ensure the survival of academic publishers, often small- to medium-sized high quality publishers, that are able to reach a wider public outside academia. This is particularly true in the Humanities, in which there is a large number of such publishers.

By the same token, the production of other open outputs involves specific cost factors – in particular, to make them FAIR and shareable. Funding can thus no longer be thought of in local (or regional) terms only, but has to enable global collaboration. Appropriate funding instruments must be devised to ensure equitable access to outputs, and to promote interactions among researchers. Such instruments should encompass support for open publications, adequate e-infrastructure, including archiving and preservation, software construction/licenses, privacy/security mechanisms, constant training of researchers and enablers, and ensure life-long education in the open science world. Openness may establish bridges, by the sharing of resources, but may also create barriers, when sharing becomes unfeasible due to the above-mentioned costs, which are often compounded by generational gaps between senior and younger researchers. Nevertheless, if without appropriate financing Open Science cannot work, without cultural change even unlimited funding will make no difference.

All these challenges are the very targets of investigation, consideration and development by researchers and associated stakeholders around the world, to construct and enable open science. Through those investments and developments, a *new type of science* is being born, concerned with building the open science research ecosystem.

4. Benefits, best practices and lessons learnt

Open science practices bring many benefits to global research collaboration, such as those mentioned in NASEM (2018): rigour and reliability – e.g., by promoting new standards for sharing data and code; the ability to address new questions "through enabling contributions from many fields, and opening up new areas of inquiry"; faster and more inclusive dissemination of knowledge, through open publications that are intended for public benefit; broader participation in research, e.g., offering opportunities to citizen scientists; effective use of resources; and improved performance of research tasks through new open tools. In some countries, passage of landmark legislation and policies have already greatly facilitated access to research outputs and expanded scientific information in the public domain.

Citizen science is also part of the open science ecosystem. It considers citizens as producers of scientific outputs (in particular data and software) that can be reused and incorporated into new knowledge. The most common kind of citizen science practice is engaging citizens in production or annotation of data. For their effective reuse by others, these products should be subject to the curation, standardization and preservation methods necessary to ensure the maximum benefit to all. While active involvement of citizens has direct dividends for science, the benefits are further multiplied by increasing the fraction of the population knowledgeable about science and supportive of it. The diffusion of science is most effective if citizens actively participate.

The increased availability of public databases has significantly accelerated advances in research. For instance, public repositories in -omics, such as GenBank, have significantly shortened the development time of essential technologies such as drugs and vaccines. In the Humanities, the digitization of resources from libraries, archives and museums has allowed research that interconnects historical documents across continents, providing new insights into, for example, social or cultural movements. In the physical sciences – e.g., in astrophysics – it is only through open data and collaboration networks that a better understanding of the origins of our universe is being achieved.

Preservation for long-term global sharing has also proved beneficial for many kinds of research, for example in the physical sciences or environmental studies, where data collected for many years is used in simulations in algorithms that did not exist at the time the data were produced. In some cases, like in the Humanities, the durability of access to research is even more important than the promptness of their availability: the best publications in this field have a long lasting impact, and must therefore be accessible for a long time.

Open science has also enhanced the peer review process by enabling comments to be made both before (through preprints) and after publication through social networking, thereby making scientific studies more robust under the scrutiny of researchers from diverse backgrounds and fields.

Open Science can play a significant role to ensure equity among researchers of developed and developing countries, enabling accessibility and sharing of scientific outputs that can be aligned to develop effective tools for mainstreaming science for peace and sustainable development.

5. Policy Recommendations/Implications

These recommendations are directed towards multiple stakeholders – individuals, institutions and, more generally, all the open science actors that should collaborate to fully realize them. They intend both to establish this ecosystem, and to continuously strengthen it. They vary in level of specificity, but all, individually and in aggregate, play a role in reaching the goals of open science. Ultimately, their implementation serves society at large by providing the foundation for scientific collaboration without borders.

1. Adopt and promote open science practices to strengthen the relationship between society and science, thereby allowing citizens to engage more fully in issues of societal importance.
2. Promote and support science, and in particular open science; it plays a critical role in mitigating global threats and disasters, and reducing risks through decreasing the knowledge gap. Use open science accordingly to make evidence-based decisions and policy.
3. Create awareness among researchers about the many opportunities offered by openness.
4. Ensure equity of access such that both producers and consumers of scientific outputs have equal access.
5. Promote cultural change in research settings to support open science practices.
6. Ensure that open science policies are harmonized to the extent possible, taking existing international agreements into account and identifying ways to improve them.

7. Create a policy environment for open science by aligning and implementing policies that are conducive to sharing research outputs.
8. Provide policy makers with appropriate access to outputs, so that they can make more informed decisions.
9. Support the development of national/international legal instruments to allow for sharing across repositories without regard to national or regional boundaries.
10. Develop cybersecurity and adequate e-infrastructure, including among others, appropriate identification and tagging for open science outputs.
11. Advance the construction of open science platforms to facilitate broader and more inclusive knowledge for scientific advancement, addressing regional problems and recognizing the value of indigenous and local knowledge.
12. Foster training in open science to construct and prepare outputs so that all can take advantage of the open movement – including open data, open software and open publications.
13. Consider adopting licensing schemes that allow the distribution of scientific outputs internationally, or developing new models more adequate for science outputs.
14. Foster public-private partnerships to enhance open science.
15. Promote open education practices, and support the production of FAIR educational materials, and the training of those who prepare these materials for designing and producing content that is approachable for potential readers.
16. Create conditions for publishers and scientific societies to work together, so that they can develop new business models for equitable publication and access.
17. Promote the rapid availability of intermediate research results in cases of major emergencies.
18. Implement appropriate regulations and incentives for good open data and open software practices, and sanctions for misuse.
19. Recognize the value of open outputs and the practice of open science as a means of creating collaborative ecosystems.
20. Recognize and reward the merit of those who work in the creation and maintenance of open outputs. Revisit existing metrics for assessing research impact, going beyond publications. Reform the research evaluation system to incentivize open research practices.
21. Explore the potential of open science practices to reduce scientific misconduct, including the fabrication and falsification of results and plagiarism.

6. Concluding Remarks

Open science is an enabler of global collaboration without geographic, temporal, social or cultural barriers.

Open science is an enabler of communication and collaboration among researchers and institutions across borders, increasing the efficiency of research. It also enhances reproducibility and avoids unnecessary duplication of research products.

Open science is an enabler of reduction of global disparity in research capacity, benefitting researchers from countries with limited resources. It also supports equitable opportunities in research for both senior and young researchers.

Open science is an enabler of scientific integrity, increasing transparency and allowing scrutiny and analysis of research projects and products.

Open science is an enabler of innovation. It ensures that its products can be rapidly translated into discoveries and technologies. It thus has the potential to engage a whole spectrum of stakeholders in the research value chain, from individual researchers to research institutions, public and private organizations and small and medium scale enterprises, start-up firms and consolidated large commercial enterprises.

Open science is an enabler of quality research.

Open science is an enabler of public policies at all levels, directly influenced by the availability of results and studies across borders.

Open science is an enabler of social good, through all of the above.

Nevertheless, openness exposes researchers to some vulnerability, which requires a supportive research culture, involving constructive criticism, safe spaces for exploratory research where there is a place for failure, and acceptance of the messiness of science.

References

Bezjak, S. et al. (2018). Open Science Training Handbook. 10.5281/zenodo.1212496.

Declaración de Panamá (2018). *Detalle de los lineamientos para la construcción de políticas de ciencia abierta en América Latina y el Caribe*. Retrieved from https://stats.karisma.org.co/DeclaracionDePanama/

NASEM (2018). National Academies of Sciences, Engineering, and Medicine. 2018. Open Science by Design: Realizing a vision for 21st century research. Washington, DC: The National Academies Press.

Wilkinson, M.D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, *3*(1), 160018. doi: 10.1038/sdata.2016.18

Members of the IAP ad hoc Open Science Working Group

Claudia Bauzer Medeiros (Chair), Institute of Computing, University of Campinas (UNICAMP), Brazil and Brazilian Academy of Sciences (ABC), Brazil
Barthélémy Raphaël Darboux, *Académie Nationale des Sciences, Arts et Lettres du Bénin*, Cotonou, Benin
Juan Armando Sánchez, Department of Biological Sciences, University of Los Andes, Colombia and *Academia Colombiana de Ciencias Exactas, Físicas y Naturales* (ACCEFYN), Colombia
Henrikki Tenkanen, Council of Finnish Academies (CoFA), Finland
Maria Luisa Meneghetti, *Accademia Nazionale dei Lincei* and University of Milan, Italy
Zabta Khan Shinwari, Pakistan Academy of Sciences, Islamabad, Pakistan
Jaime C. Montoya, College of Medicine, University of the Philippines and National Academy of Science and Technology, Philippines
Ina Smith, Academy of Science of South Africa (ASSAf), Pretoria, South Africa
Alexa T. McCray, Harvard Medical School, and the National Academies of Sciences, Engineering and Medicine, USA
Koen Vermeir, Global Young Academy

These members were selected by the IAP Steering Committee from among 27 nominations of experts received from member academies.

The work of this group was assisted via the inputs from 11 academies who responded to the UNESCO request to complete a survey on the current understanding of Open Science. Of these 11 surveys, 4 were received from Asia, 2 from Europe, 4 from the Americas, as well as 1 from a global academy.

IAP would like to thank all those academies who responded to the UNESCO questionnaire as well as those who nominated experts for the Working Group. IAP also thanks the Working Group members, as well as reviewers András Holl (Hungarian Academy of Sciences), Yves Juillet (French Academy of Medicine, *Académie Nationale de Médecine*), and Yasuhiro Murayama (Science Council of Japan) who provided helpful feedback on a draft version of this document.