

# Towards wide-scale adoption of open science practices: The role of open science communities

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## Abstract

Despite the increasing availability of Open Science (OS) infrastructure and the rise in policies to change behaviour, OS practices are not yet the norm. While pioneering researchers are developing OS practices, the majority sticks to *status quo*. To transition to common practice, we must engage a critical proportion of the academic community. In this transition, OS Communities (OSCs) play a key role. OSCs are bottom-up learning groups of scholars that discuss OS within and across disciplines. They make OS knowledge more accessible and facilitate communication among scholars and policymakers. Over the past two years, eleven OSCs were founded at several Dutch university cities. In other countries, similar OSCs are starting up. In this article, we discuss the pivotal role OSCs play in the large-scale transition to OS. We emphasize that, despite the grassroots character of OSCs, support from universities is critical for OSCs to be viable, effective, and sustainable.

**Key words:** open science; science policy; community management; open access; open source

## 1. Introduction

Over the past years, science has witnessed a shift towards openness, transparency, and reproducibility—a movement known under the umbrella term ‘Open Science’ (OS).<sup>1</sup> In response to increased awareness on existing challenges related to the reliability and accountability in scientific work, scholars<sup>2</sup> are motivated to increase the transparency of various aspects of their work, starting from the initial research and analysis plans to the dissemination of the final product (Bezjak et al. 2018; Munafò et al. 2017; Nosek et al. 2015, 2018; Stall et al. 2019). In parallel, expectations from journals, funders, and policy makers to improve the accessibility and transparency of scholarly products are steadily increasing (Aczel et al. 2019; Burgelman et al. 2019; Morey et al. 2016; Perkel 2019; SPARC Europe 2019; Teytelman 2018), further feeding the upward spiral towards more transparent workflows.

By opening up their practices, scholars make their work less error-prone (Fosang and Colbran 2015; Hales et al. 2019) and more visible, not only to peers from the same and other scientific disciplines—as evidenced by higher citation rates (Colavizza et al. 2020; McKiernan et al. 2016; Piwowar and Vision 2013)—but also the general public, who can appreciate the economic benefits of knowledge dissemination (Fell 2019). Moreover, engaging in OS practices facilitates the sharing and reuse of data, materials, and code in the scientific community (Allen and Mehler 2019; Milham et al. 2018), contributes to enriched scholarly output and literacy, and increases trust in the scholarly process (Tennant et al. 2016), a strong *desideratum* in times of increased scrutiny and opinionated discussions over scientific findings (Baker 2016; Cook et al. 2018; Jamieson et al. 2019). As such, adopting OS practices provides tangible benefits for individual researchers, the scientific community, and society at large.

This new drive towards openness and transparency has been accompanied by attempts to change how open workflows are facilitated. On the one hand, technological and methodological innovations are spearheaded by the research community and provide open solutions for individual scholars (e.g. the OS Framework,<sup>3</sup> a project management platform for sharing data, code, and preprints). On the other hand, and possibly also as a reaction to bottom-up initiatives, OS is encouraged through changes in policy and reward structures, for example, through badges for crediting OS practices (Aczel et al. 2019; Kidwell et al. 2016; Nosek et al. 2015), dedicated funding for replication research,<sup>4</sup> or the OS Policy Platform established by the European Commission (EC).<sup>5</sup>

Yet, many OS events (e.g. workshops, conferences, symposia, and discussion groups) often attract innovators and early adopters only, creating so-called ‘open science bubbles’. While these scholars are central to the initial creation and adoption of innovative workflows, a critical mass is needed for wide-scale adoption; moving from OS advocacy to an actual change in behaviour remains challenging when OS is not accepted as normative by the wider scientific communities (e.g. Houtkoop et al. 2018). In this article, we showcase the role of OS communities (OSCs) as learning groups of scholars that facilitate effective adoption, and thus normalization, of policy changes and technological innovation in contemporary science (Nosek 2019).

## 2. The transition to OS

The rise of the OS movement comes with an increasing need for research environments to adapt to the new societal and technological realities of the past decade (Burgelman et al. 2019). For example, many OS practices are linked to the use of web-based technologies and social media networks, which are becoming regular tools for data collection, sharing, analysis, and collaboration (Voytek 2017). There is no single definition or agreement on what the core components of OS practices are; it ultimately depends on the goals of the stakeholders affected by the changes (Fecher and Friesike 2014). For example, for individual scholars, OS might come down to the skills and research practices themselves, as suggested in the training handbook of the FOSTER project (Pontika et al. 2015). For librarians, the priority might instead be the sustainable dissemination of information within the academic community (Deville et al. 2019), whereas policy makers might be more interested in quantifying the societal impact of scholarly output (Bornmann 2017). In qualitative social science research, there is a long-standing interest in developing an ethical and mutually respectful relationship between researcher and participant, and in developing and promoting research that ‘make[s] a difference in everyday lives’ (Denzin and Giardina 2009: 13). As OSCs, we align with the EC and emphasize the collaborative aspect of OS:

Open Science represents a new approach to the scientific process based on cooperative work and new ways of diffusing knowledge by using digital technologies and new collaborative tools. The idea captures a systemic change to the way science and research have been carried out for the last fifty years: shifting from the standard practices of publishing research results in scientific



national strategic research evaluation protocol,<sup>19</sup> recent agreements on the change to be made in the recognition, and rewards system to further facilitate positive incentives towards OS,<sup>20</sup> and by some universities that have started reserving funds for OS implementation in their strategic plans.<sup>21</sup> Of note, the Dutch The Ministry of Education, Culture and Science, following Finland, in 2017 adopted the integral practice of OS, including Open Access (OA), as standard in government-funded science and launched a national plan to implement OS (OCW 2017).

Although both bottom-up and top-down efforts and initiatives are promising, so far they have not had the fortitude to usher in a wide-scale culture change in academia. Below we describe three challenges that this transition currently faces.

### 3. Challenges in widespread adoption of OS

#### 3.1 Reaching critical mass: from pioneers to common practice

Despite the presence of individual innovators and recent policy-, funding-, and incentive-driven changes towards the adoption of OS, the challenge remains how to mobilize a critical mass of scholars to achieve this cultural change. On the one hand, only limited impact is achieved by individual innovations that do not reach widespread adoption by the community. On the other hand, policy changes cannot afford to bypass the sentiment of the communities in which they are adopted, else they risk being misdirected, ineffective, and possibly even counterproductive. Experts involved in central policy organs (such as the EC) responsible for encouraging OS from a top-down perspective may find it difficult to effectively reach scholars. Although there is likely no societal agent that can single-handedly solve the problem of widespread OS adoption (see Munafò 2019 for a discussion on the role of institutions), we argue that bottom-up OSCs, due to their peer-based character and format, have the strongest leverage to reach a critical mass by giving voice to the scholars themselves.

#### 3.2 The perceived costs of change

Whereas the advantages of OS may appear clear from a principled perspective, introducing and adopting change *in practice* can be met with some resistance. In a workshop report, Sholler et al. (2019) noted different sources of resistance among scholars. For example, those willing to adopt OS practices may encounter inertia from their collaborators or supervisors who prefer their established, closed, workflows due to their (perceived) past efficiency. Additionally, reluctance may stem from fear of close scrutiny of their work, or from fear of getting scooped. Similarly, one can encounter unwillingness to adopt change because the immediate costs of the switch can be deemed too high relative to the potential long-term benefits. In some cases—and especially when a network of easily accessible information is not in place—it may seem costly or daunting to find out how to handle a situation. For instance, it is sometimes unclear whether publicly sharing data would pose a risk to vulnerable populations. This uncertainty could further increase the tendency to follow established routines (i.e. no data sharing). Such resistant behaviour finds fertile ground in local environments where OS practices are not seen as normative (Houtkoop et al. 2018). As mentioned above, innovation must thus be made both visible and rewarding for scholars. OSCs can aid in making OS practices visible through different platforms and workshops by creating a low-threshold exchange of knowledge, lowering the bar for scholars to adopt new workflows and find support from colleagues and mentors.

#### 3.3 Disciplinary differences

Lastly, the need for adoption of OS practices varies across disciplines. For example, working with open data and materials is more customary in biomedicine than in psychology or other social sciences, while publishing open access is more popular in psychology (Hardwicke et al. 2019). In some disciplines, particularly the social sciences, principles that overlap significantly with those of OS have been associated with calls for civic engagement (McIlrath and Lyons 2012), community-based research (Munck et al. 2014), and other activities that integrate transparency, reflexivity, and public engagement, such as service learning (Bingle and Hatcher 1996; Giles and Eyer 1994). Such diversity opens fruitful avenues to share best practices across disciplines. By virtue of their interdisciplinary character and university-wide involvement, OSCs form the ultimate platform to combine multidisciplinary insights and knowledge and provide broad, but at the same time tailored, advice and knowledge exchange among scholars who have different backgrounds, questions, and needs.

### 4. Open science communities

#### 4.1 The role of communities in shaping the transition

Incentivizing OS policies and providing OS infrastructure for scholars are important steps in promoting scientific values such as transparency, reproducibility, accessibility, and inclusivity. In order to change the current research culture, however, it is crucial that the scholarly community *itself* aligns with these values and adopts OS practices as the new standard. As mediators between policy makers and scholars, local bottom-up networks play a central role in identifying obstacles that hinder scholars in opening up their workflows, and provide the support needed to foster cultural change at the institutional or organizational level (Nosek 2019).

Through the wide variety of backgrounds and scientific expertise of their members, bottom-up networks create a learning environment where scholars can acquire the skills to conduct open, transparent, and reliable research, and are able to discuss OS practices among their peers. Moreover, local grassroots networks increase the visibility of these practices within their local communities, which in turn contributes to changing the descriptive norm of how research is conducted. As of today, more than 200 networks exist worldwide to increase transparency and accountability of scholarly products in various scientific fields.<sup>22</sup> The International Network of OS Communities (INOSC) constitutes a collaborative network that currently comprises eleven Dutch university cities, one in Ireland, and a consortium of universities in Sweden.

#### 4.2 Target audience: early majority

Wide-scale adoption of innovation takes time, as individuals are not equally open to change. According to Rogers (2003), adopters of innovation can be categorized as innovators, early adopters, early majority, late majority, or laggards. *Early majority* comprises individuals that are open and curious with regards to OS but, as of yet, have little to no experience with OS practices. They want to learn more, understand why it is important, and are willing to implement (some) OS practices in their daily workflow. Encouraging adoption of OS by the early majority can facilitate a paradigm shift in research practices, and is therefore the needed step to engage the *late majority* in adopting OS practices. The *early majority* is thus the main target audience for OSCs.

We emphasize that, although the greatest opportunity to facilitate the transition to OS at a large scale lies within the early and late





existing tools and courses (e.g. offered by support staff or the university library). Therefore, a strategic plan is advisable. For instance, the OSC coordinator could schedule an appointment with a faculty dean (or, if possible, the university president/rector and/or the executive board), explain the added value of an OSC to the existing local offers, and ask whether the faculty or university would be willing to fund such an initiative if it proves ‘successful’ one year after kick-off. If needed, the RE-AIM planning and evaluation framework (Glasgow et al., 2019) may be used as an evaluation tool to evaluate the success of the initiative. For instance, the outcomes of measures taken to increase the visibility of OSCs may be measured through reach (i.e. the number of scholars that have enrolled in their local OSC communities), and surveys may be used to understand the adoption and/or perceived effectiveness of OS practices.

## 5. Conclusion

OS is becoming an increasingly necessary and recognized *modus operandi* in scholarly environments, but actual adoption lags behind on the widely shared vision. Bottom-up innovations by pioneers, paralleled by top-down OS incentives and policies, are crucial steps in the direction towards change. However, wide-scale adoption of OS practices requires a culture change that leads to normalization among members of the scientific community. In this article, we have identified three challenges that stand in the way of wide-scale adoption of OS practices: (1) reaching a critical mass; (2) the perceived cost of change; and (3) disciplinary differences. We have argued that a network of local OSCs can overcome these challenges. OSCs play a central role in identifying obstacles that hinder scholars in opening up their workflows, hence providing the needed support to foster culture change at the institutional level. Together, we make science more open for the benefit of science and society.

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## Authors’ contributions

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## Competing interest statement

Most authors of this article (K.A., L.B., R.C., A.E., R.Fi., R.Fo., V.E.H., S.H., M.M., A.Sa., A.Sc., H.S., Z.S., M.T., O.R.A., A.V., and R.Z.M.) are involved as coordinators in local OSCs, and are involved in organising, promoting, and facilitating open science (events).

## Notes

1. In this document, we use the term ‘Open Science’ following the result of the public consultation on Science 2.0 Science in Transition (<https://tinyurl.com/sci2-2015>; see also Burgelman et al. 2019), which popularized the term. Thus, the term ‘science’ is used in its broadest sense and includes humanities, social sciences, and engineering; that is, it more suitably refers to any form of scholarship.
2. The term ‘scholars’ is used here as an umbrella term for all individuals who are in some way involved in research practices within academia as well as broader research areas.
3. <https://osf.io/>
4. <https://tinyurl.com/25r7wuxf>
5. <https://tinyurl.com/EU-OSPolicy-Platform>
6. <https://www.gnu.org/>
7. The count of supercomputing systems running on Linux can be viewed at: <https://www.top500.org/statistics/details/osfam/1/>
8. <https://galaxyproject.org>
9. <https://galaxyproject.org/blog/2020-08-10k-pubs/>
10. <https://reproducibilitea.org/>
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20. <https://tinyurl.com/room-talent>
21. See, for instance, recent strategic plans at Utrecht University (<https://www.uu.nl/en/research/open-science/about-us>), University of Twente (<https://www.utwente.nl/en/organisation/about/shaping2030/>), and Delft University of Technology (Haslinger 2019).
22. A crowdsourced list of grassroot initiatives is available at <https://tinyurl.com/y2l9gpxc>.
23. The INOSC Code of Conduct template can be found at <https://osf.io/6gsye/>.
24. <http://www.startyourosc.com/>

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