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Case Report

Open Science Support as a Portfolio of Services and Projects: From Awareness to Engagement

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Received: 20 February 2018; Accepted: 12 June 2018; Published: 19 June 2018

Abstract: Together with many other universities worldwide, the University of Göttingen has aimed to unlock the full potential of networked digital scientific communication by strengthening open access as early as the late 1990s. Open science policies at the institutional level consequently followed and have been with us for over a decade. However, for several reasons, their adoption often is still far from complete when it comes to the practices of researchers or research groups. To improve this situation at our university, there is dedicated support at the infrastructural level: the university library collaborates with several campus units in developing and running services, activities and projects in support of open access and open science. This article outlines our main activity areas and aligns them with the overall rationale to reach higher uptake and acceptance of open science practice at the university. The mentioned examples of our activities highlight how we seek to advance open science along the needs and perspectives of diverse audiences and by running it as a multi-stakeholder endeavor. Therefore, our activities involve library colleagues with diverse backgrounds, faculty and early career researchers, research managers, as well as project and infrastructure staff. We conclude with a summary of achievements and challenges to be faced.

Keywords: open science; open access; service portfolio; publishing; repositories; research information

1. Introduction

Together with many other universities worldwide, the University of Göttingen has aimed to unlock the full potential of networked digital scientific communication by strengthening open access as early as the late 1990s. Open science as the paradigm to draw on digital technology for research processes and collaboration and to make these transparent as well as comprehensible, followed these early approaches for open access to research results. Consequently, policies at the institutional level to define and foster open science emerged and have been with us for over a decade now. Experience shows that the transition to open science is a multi-layered process, which builds on communities and communication, services and support, ideas and visions in order to change the conventional research and scholarly communication system.

Bringing open access forward has been defined as one of the strategic goals of Göttingen State and University Library (SUB Göttingen)[1]. When it comes to making open access and open science happen at Göttingen Campus[2], the university library is one of the chief players that provides a wide range of open science services and activities. These include awareness raising and open science training, local services and support for Göttingen's researchers and transforming institutional acquisition budgets from journal subscriptions to open access publishing funds and agreements. All these activities are delivered in a heterogeneous setting: we as a library are responsible for 13 local faculties including a medical school and large Humanities faculty, serve national obligations and offer dedicated infrastructures and support to European digital humanists.

How that plays out in designing aligned services might be highlighted with the following. While a field such as high energy physics has established a rich pre-publication discussion culture taking place on arXiv.org and managed to organize SCOAP3 (Sponsoring Consortium for Open Access Publishing in Particle Physics), a partnership that achieved almost 100% open access for the field's published results, other disciplines are just starting to set up preprint servers (e.g., in biology or chemistry with bioRxiv.org and chemRxiv.org). Even in fields like medicine and health sciences where selection via peer review in journals even decades after arXiv.org seemed to be the only way to publish research results, there are now initiatives to set up a preprint service[3].

Fields like biology or geosciences have developed widely-accepted disciplinary computing sciences, whereas parts of the humanities or social sciences find it hard to even publish in electronic journals, due to fragmentation and economies-of-scale challenges. To meet these disciplinary differences, our library is heavily involved in national and international projects developing infrastructures and services for open access and open science that seek to balance general efforts fit for all disciplines with customization for disciplinary or specific audiences' needs. Our open science activities (which we describe briefly in Table 1) are comprised of electronic publishing and open access, but also reach from research data management, virtual research environments, to digital repository networks, as well as policy making and awareness building.

From a library perspective, the transition to open access both disrupts traditional workflows and broadens the scope of activities. The acquisition aspect—the selection and licensing of resources—increasingly focuses on combining payments for open access publishing such as article processing charges (APCs) with subscriptions and holdings. At the same time, additional support of and services to researchers are needed. In addition, with the shift from print to digital resources, the library as a space is transformed, the latter freeing up space for learning and collaboration. For library employees, these changes can be gradual, but more often, they require further training, and can sometimes lead to restaffing in the long term.

This brings projects into a new perspective. Projects may have been considered merely as add-ons rather than integral entities based on the fact that project staff are often appointed through fixed-term contracts. Due to the ongoing transformation of libraries, projects are increasingly becoming the "new normal" as important agents of change and are used for both stepping up the range and the quality of services. In addition, projects offer an opportunity for experimentation, i.e., to explore, test and evaluate new service areas. Not surprisingly, libraries adopting this approach have the ability to run other change processes as projects, i.e., the line is blurred, and what remains are differences in size and funding streams (board funds from the university's own resources versus third-party funds from external research funding organizations). However, the sustainability of service areas that have

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1 Göttingen State and University Library, https://www.sub.uni-goettingen.de/en/about-us/portrait/strategy/.
2 Göttingen Campus is an alliance between the university and local non-university research institutions, which have come together to promote research, teaching and the training of young researchers; cf. http://www.goettingen-campus.de.
3 The Yale University Open Data Access (YODA) project, http://yoda.yale.edu/medrxiv. For more information on the debate, see, e.g., [1].

emerged with the activation energy of projects can only be achieved if these are fully integrated into the library's operation and budget planning, ideally right from the start.

In the following, we will outline the application and further development of strategies at Göttingen Campus and highlight a range of activities that are instrumental for the implementation.

Table 1. Overview of mentioned open science projects and initiatives.

Activity/Initiative	Type	Focus	Link
*metrics	Project	Alternative metrics	metrics-project.net
COAR	Association	Repositories	coar-repositories.org
Data Science Summer School	Event	Open data/training	https://tinyurl.com/UGOE-datasummer2018
Deep Green	Project	Open access	deepgreen.kobv.de
DOAJ	Infrastructure	Index for peer-reviewed OA journals	doaj.org
DRIVER	Project	Repositories	driver-repository.eu
European Open Science Cloud (EOSC)	Project	Infrastructure	eoscpilot.eu
FOSTER, FOSTER Plus	Project	Open science training	fosteropenscience.eu
GoeScholar	Infrastructure, service	Repositories	goedoc.uni-goettingen.de
Göttingen eResearch Alliance (eRA)	Service, support	Research data management	eresearch.uni-goettingen.de
Göttingen Research Online (GRO)	Infrastructure, service	Publication data management	gro.uni-goettingen.de
Göttingen University Press	Service, infrastructure	Scholarly publishing	univerlag.uni-goettingen.de
Hacky Hour Göttingen	Community building, event, mailing list	Open science tools	hackyhour.github.io/Goettingen
HIRMEOS	Project	Scholarly publishing	hirmeos.eu
Knowledge Unlatched (Selection Committee 2018)	Initiative	Open access	knowledgeunlatched.org
Open Access 2020	Initiative	Scholarly publishing	oa2020.org
Open Coffee Lectures	Community building, event	Open science	www.sub.uni-goettingen.de/lernen-lehren/kurse-fuehrungen/coffee-lectures/
Open Science Göttingen Meet-up	Community building, event, mailing list	Open science	www.sub.uni-goettingen.de/en/electronic-publishing/open-science/
OpenAIRE	Project, initiative	Infrastructure and network, open science	openaire.eu
Reading Group on Data Science Literature	Community building, event	Training	–
ROpenSci	Initiative	Software tools, community building	ropensci.org
SCOAP3	Initiative	Scholarly publishing, open access	scoap3.org
SUB Göttingen Facebook Page	Community building, outreach	-	facebook.com/SUB.INFO
WG Association of European Research Libraries (LIBER)	Working group (WG)	Research libraries as infrastructure	https://libereurope.eu/strategy/research-infrastructures/committee
WG euroCRIS	Working group	Repositories, current research information systems	www.eurocris.org/community/taskgroups/cris-ir
WG European Commission	Working group	Scholarly publishing	https://preview.tinyurl.com/EC-wg-scholpublishing
WG Knowledge Exchange	Working group	Open access	www.knowledge-exchange.info/projects/project/open-access
WG Research Data Alliance	Working group	Research data management	www.rd-alliance.org/groups/libraries-research-data.html

2. Bridging the Gap between Policy and Practice

Institutional policies on openness, open access, open science or research data endorse and nurture desired practices while leaving room for disciplinary approaches that should be defined at the departmental level. To be effective, such policies need to be reassessed and updated regularly, to ensure their alignment with the principles and practices commonly shared by the wider research community or the legislative framework (e.g., intellectual property rights). Input from researchers is therefore essential for an effective and balanced policy. Yet, it can be difficult for researchers to navigate through these policies and their institutions' supporting services on their own. Librarians provide advice and guidance on open access to university staff, researchers and postgraduate students. In other words, librarians play a key role in the open science movement as they bridge the gap between policy and practice, i.e., act as mediators and enablers through translating open science policies into practice, and vice versa.

Pursuing the goal of making research results of its researchers as widely accessible and usable as possible, the University of Göttingen and the University Medical Center Göttingen (UMG) adopted a joint policy on research data in July 2014 and a revised open access policy in November 2016.[4] The current open access policy recommends authors to retain their rights to ensure unrestricted access to and dissemination of their works; endorses depositing a copy of the manuscript in the institutional repository GoeScholar upon publication and informs researchers about the University's open access options such as the open access publication funds, Göttingen University Press (hybrid publishing model of full open access with print on demand) and further service areas. The 2016 policy builds on the university's initial Open Access Resolution from December 2005 that focused on general benefits of open access, encouraged researchers to engage and promoted free access through self-archiving.

The policy on research data was drafted by several stakeholders in the university (including research support, the legal department and the library). Both the university and the medical center adopted it in July 2014.[5] The policy outlines the responsibilities of data producers and defines available support in the context of research data management. It encourages researchers to ensure unrestricted access to and re-use of research data, in particular of data required to validate results presented in scientific publications. Further, it clearly states that the university supports and advises researchers on data management issues and provides services for data storage and preservation. SUB Göttingen is responsible for the implementation, coordination and continuation of the strategy within the university and connects Göttingen researchers with existing tools and digital information infrastructures.

A common challenge is to effectively communicate institutional policies to the institution's academic community as a whole: these principles should not just look good on paper. Although open access has become a relatively well known concept in many disciplines, uncertainties about common practices and tools still prevail among researchers. The key to successful policy implementation is to send a clear and consistent message across campus engaging all research communities and to equip them with skills needed to turn policies into practice. This can be achieved through several paths, such as the library website, mailing lists, workshops, information and training sessions or informal meet-ups. In addition, to efficiently support researchers, it is essential to create and further develop a network of people across campus that interlinks service and policy areas, covering the library, the research support office and the research integrity office.

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[4] University of Göttingen, Official Announcements, No. 65, 6 December 2016, https://www.uni-goettingen.de/de/amtliche-mitteilungen-i-ausgabe-65-06122016/552696.html.

[5] Research data policy of the University of Göttingen (incl. University Medical Center), http://www.uni-goettingen.de/en/488918.html.

2.1. Raising Awareness and Training for Open Science

Taking open science to the next level first requires researchers' awareness of the importance of openness, followed by skills development such as the adoption of new research practices. The library actively informs about open access services and current open science activities via direct communication with researchers or research support staff, as well as through mailing lists, and organizes events such as roadshows, hands-on workshops or low-threshold events, e.g., our Open Coffee Lectures to reach walk-in audiences. Other events such as summer schools allow in-depth interaction with specific target groups or communities.

A communication and information channel to raise attention for open science and to coordinate efforts was first established in autumn 2016, mainly targeting early career researchers at Göttingen Campus. To date, there are several mailing lists, "Open Science", "Goe Teaching Open Science" and "Hacky Hour Göttingen", collaboratively run by librarians and early career researchers. The "Open Science" mailing list informs subscribers about local and global open science events, such as meet-ups, workshops and webinars. The list also spreads the word about useful tools for research workflows, job postings and recently published reports and research articles. "Goe Teaching Open Science" is used to organize meetings to discuss how open science teaching and training can be better incorporated in research integrity trainings and graduate school level curricula, as well as to collaboratively develop teaching materials for these sessions. Besides mailing lists, SUB Göttingen has been running a Facebook Page[6] since 2011 to inform about open science events hosted at or by the library.

At the European level, the EU-funded project FOSTER Plus[7] engages in open science training of researchers and trainers at the institutional level. It brings together 10 experienced partners across five European countries. In the first project phase from 2014–2016, the project organized over a hundred face-to-face training events across 28 European countries and developed 25 online courses. These activities reached over 6300 participants all over Europe. In addition, the project collected more than 2000 training materials, which were categorized according to an Open Science Taxonomy at the FOSTER portal. The FOSTER portal is an e-learning platform where users can learn about open science or re-use training materials. The current project phase (2017–2019) intensifies and expands these activities. It develops new online courses that go beyond raising awareness and targets disciplinary communities such as the life sciences, the social sciences and the arts and humanities. In some disciplines, open research practices are already the norm, whereas others have just started to explore integrating open science principles into their research routines relatively recently [2]. Therefore, FOSTER provides discipline-specific training and supports knowledge exchange and learning. In addition, the project strengthens the open science training capacity by initiating a trainers' community and also training the trainers. Resources such as the recently released open science training handbook, re-usable training materials and a trainers' directory, where users can find speakers for training events, foster the delivery of training beyond the project. This approach ensures that open science awareness and skills arrive in and grow further at the level of research institutions.

Another initiative that steps up open science knowledge at Göttingen Campus and beyond is the Data Science Summer School[8], a short-term program that welcomes early career researchers from across all disciplines. The course combines theoretical lectures and interactive sessions, giving students the opportunity to directly apply their newly-acquired skills and knowledge through collaborative hands-on training. Participants learn about data management, sharing and processing, as well as different data science methods.

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[6] SUB Göttingen on Facebook, https://www.facebook.com/SUB.INFO.
[7] Fostering the practical implementation of open science in Horizon 2020 and beyond, https://www.fosteropenscience.eu.
[8] Data Science Summer School, http://www.uni-goettingen.de/de/data+science/575381.html.

2.2. Building Open Science Communities

Elements of the open science agenda are becoming increasingly familiar to early career researchers [3]. However, at the moment, there are only a few opportunities to learn about and to discuss open science topics, such as available options to actively practice open science. The key to improving the current situation is to build up a local open science community and offer an environment where scholars from all career stages and other open science enthusiasts with different backgrounds can come together to meet like-minded people, exchange ideas and experiences and drive open science at and beyond Göttingen Campus.

The Open Science Göttingen Meet-Up launched in autumn 2016 and since then has brought together researchers, librarians and other individuals interested in open science about every three months. Usually, participants agree before each meeting on topics and agenda, whereas library staff members act as facilitators and less as agenda setters. Previous meet-ups included topics such as incentives for practicing open science, raising awareness, open data, researcher profiles and impact metrics. One example is worth mentioning as participants had expressed their interest in sketching and graphic recording to visualize research processes or results. In summer 2017, we organized the visit of Patrick Hochstenbach, digital architect at Gent University Library and artist[9], a colleague we have been working with in the context of digital repositories. He guided participants through an intense and highly instructive workshop that equipped everyone with valuable information, as well as new practical skills on how to conceptualize sketching and create visual graphics, which we applied to express a topic of open science.

Closely related to the meet-ups as a format to engage communities is our Hacky Hour Göttingen[10], initiated by a doctoral student together with librarians, a monthly open meeting that focuses on computational tools and code. In an informal setting, 10–20 participants offer each other support in computational problems and present their approaches, such as how to write a thesis with R Markdown, a basic introduction to MathJax, Jupyter notebooks and an introduction to repositories. No prior knowledge is needed, and everyone, regardless of their career stage, status, experience or background, is welcome to participate, test tools or methods and engage in the discussion. All meet-ups and Hacky Hours are documented through notes on Etherpad, a web-based collaborative real-time text editor, and everyone is invited to join Hacky Hour's Gitter chat (instant messenger) and our mailing list where ideas and questions can be posted before and after the meet-ups. Thereby, Hacky Hour maintains an open communication channel in between meet-ups and is deliberately designed as low threshold, meaning that walk-ins and new members can join the community at any time.

3. Publishing Services and Research Support at Göttingen Campus

To bring open science to full acceptance, publishing options for research results need to be part of the picture, and open access currently seems to be the best fit for a changing research paradigm. Thus, our library strongly supports the goal of maximizing open access to publications and related research outputs, both through its publishing services, run on behalf of the university, as well as being active in the transformation of the scholarly communication system and its political, legal and organizational framework. To meet the latter, several library staff members are active in lobbying or working groups for open science, scholarly communication and open access publishing.

At the service level, user needs determine which and how publishing services are designed and run. Our publishing services take into account that publishing draws on four core functions, namely registration, certification, dissemination and archiving. Certification for example requires that publishing infrastructures meet the expectations of target groups when it comes to citability, review processes or quality control.

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[9] https://github.com/phochste.
[10] Hacky Hour Göttingen, https://hackyhour.github.io/Goettingen.

An illustrative example for this approach is the adapted collection policy of GoeScholar, the institutional repository for the University of Göttingen. The initial collection policy covered parallel versions of already published work only, with a strong preference for peer-reviewed articles. The idea was to show Göttingen authors that they would self-archive among peers, meaning that all publications on GoeScholar were of similar origin. Over the years, it became evident that authors wanting to self-archive do not make that decision based on the functionalities of the chosen platform, but rather on whether the platform reaches their intended audiences. Author uploads remained at a very low level, and the steady growth of content on GoeScholar was a result of the repository team's effort. At the same time, research groups kept on requesting an open access platform for primary publication of more informal publication types in a formal (citable) way in open access, such as working papers or report series. The policy therefore opened for primary publications, and the GoeScholar team supports researchers with consulting on publishing concepts, editorial processes such as style sheets or quality control, licensing and persistent identifiers (e.g. DOIs).

Researchers from book-oriented disciplines continue to publish mainly in scientific presses. However, the commercial publishing system continues to fall short in offering affordable open access options for books. As monograph publishing mostly takes place in small to medium-sized publishing houses heavily relying on print sales (including most of the Anglo-American university presses), these presses tend to be highly selective when taking up titles into their publishing program, resulting in scarce publishing options, especially for niche topics, early career authors or those willing to publish open access. Therefore, the university library runs Göttingen University Press (GUP) to offer reliable and affordable publishing options for Göttingen authors. Its open access-focused mission and how it collaborates with a group of other German-language university presses have been thoroughly described by Bargheer and Pabst [4]. GUP books are published in a hybrid model of small print runs combined with an open access version on the press' DSpace-based repository, open for metadata harvesting via OAI-PMH and all equipped with a DOI. Just like most of the newer library-led university presses, it operates with lean workflows: authors submit manuscripts based on templates provided by the press, and digital versions continue to be published as PDF files. Sophisticated XML-based workflows certainly produce digital objects with higher open science and reuse potential. However, as they place additional workload on authors and editors and require activation energy, as well as permanent support from technical staff, they continue to be out of scope for the majority of smaller presses, such as ours. However, some recently-founded presses have benefited from the German Research Foundation (DFG) funding programs, which enabled them to enhance their production processes and to develop alternative business models for monograph publishing (e.g., Heidelberg University Press[11]).

Although open access books have gained momentum at the institutional level over the last few years, they continue to play a more minor role than their social and scientific potential would suggest. Overall, this reflects the fact that open access in book-oriented disciplines, such as the humanities, continues to grow at a slower rate than for example in the natural sciences. This results from a lower standardization level of book publishing and a lack of economies-of-scale ([2,4–6]) in comparison to journal articles, but also with existing reputation-building processes in the mentioned disciplines that would require new reading and validating habits (e.g., accepting digital publications in tenure and promotion).

3.1. Enhancing Institutional Publishing and Integration of Monographs in Open Science Infrastructures

Monographs continue to be important means of communication in the humanities and social sciences; more than papers and other shorter publication formats, they enable scholars to deal with differentiated and complex questions exhaustively. They can open up new research perspectives, i.e., they can be ascribed greater innovative power than articles.

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[11] Heidelberg University Press, http://heiup.uni-heidelberg.de/?lang=en.

> Monographs provoke debate, shift paradigms, and provide a focal point for research. It is not surprising [...] that the authors of monographs feel a personal connection with the form and content of the works they publish, nor that monographs play a vital role in the careers of many scholars as key markers of esteem and quality (Crossick, G. [7]).

In addition, since the publication of monographs requires expertise acquired over a long period of time, they help to define scientific profiles and thus gain decisive importance for academic careers. Even if not in the same way in all countries, monographic publications are the condition for acquiring academic qualifications, in Germany, e.g., a PhD or habilitation. The importance of scientific monographs for the Humanities and Social Sciences (HSS) has become increasingly significant with the possibility to publish in open access, as open access enhances the visibility and dissemination of research results [8]. The publication of scholarly monographs in open access has great advantages for scientists as authors and as readers: It increases the visibility of their publications, ensures a wider dissemination of research results in international and interdisciplinary contexts, enables added value such as comprehensive indexing and also allows the innovative features (e.g., annotations or cross-linking) while drawing on the conventional format of the book. However, adopting open access publishing models for scholarly monographs is still slower than for scholarly essays [9,10]. As [11] have shown, scientific journals and articles travel through the digital transformation much more smoothly than books, as they have to overcome fewer technical and conceptual barriers, be it in terms of reading habits, reputation gain or storage concepts. In particular, prestige and reputation play a decisive role, especially if a discipline depends on a narrow circle of traditional high-quality publishers.

In recent years, several infrastructures and services have been developed in order to facilitate the integration of monographs into the open access realm. Nevertheless, the landscape of scholarly publishing is still highly fragmented, with different national, linguistic and subject-specific aspects. While in the Science, Technology and Medical disciplines (STM), the publishing system is strongly concentrated around the top five commercial publishers (Elsevier, Sage Publications, Springer Nature, Taylor & Francis, Wiley-Blackwell) [12], as is shown by their share of papers published by discipline, the situation of the HSS is characterized by the fact that, in addition to the large publishing houses, there are numerous smaller university presses and growing online platforms that bring together several publishers from different national, linguistic and scientific communities. Although a single and unified publishing system, which would cover the whole variety of publication situations and opportunities in Europe, might seem purely utopian or not worthwhile to some people, it cannot be denied that the current uncoordinated situation is a major obstacle hindering the integration of HSS into open science structures.

In order to address the above-mentioned situation, the European network OPERAS [12] initiated the project HIRMEOS (High Integration of Research Monographs in the European Open Science infrastructure, hirmeos.eu), a 30-month EU project funded under the Horizon 2020 program bringing together nine partners from six different countries and five digital publishing platforms: EKT Open Book Press (Greece), Göttingen University Press (Germany), Open Access Publishing in European Networks (OAPEN) (Netherlands), OpenEdition Books (France) and Ubiquity Press (U.K.). The project enables peer reviewed open access books from publishing platforms based on different architectures and software to become an integral part of the open science system by adopting common standards and shared functionalities on these platforms. Participating platforms will for example use the same metadata—authors' ID, documents' ID, Directory of Open Access Books (DOAB) peer-review types, Creative Commons Licenses, usage metrics based on joint standards, citations/reviews, social media impact—and implement a set of common services as a result of the project. This approach allows a natural growth of a horizontally-integrated publication 'ecosystem' able to take up new partners and

[12] Open access in the European research area through scholarly communication, operas.hypotheses.org/.

platforms. The described process is supported with thorough implementation guidelines for each of the functionalities.

More specifically, the participating platforms will be enriched with tools that enable the identification of the monographs, user authentication and interoperability (via DOI, ORCID, FundRef). Other tools will enable entity extraction (INRIA (N)ERD) and annotation of monographs (Hypothes.is), as well as the collection of usage and alternative metrics data. HIRMEOS will also enhance the technical capabilities of the Directory of Open Access Books (DOAB), the most important indexing service for open access monographs, to provide automated information for inclusion and develop a structured certification system, which will make it possible to document the peer review of each monograph published on the digital platforms involved in the project.

The library contributes to several work packages and leads the work on community outreach and exploitation of project results. In particular, Göttingen is responsible for developing HIRMEOS's communication strategy, strengthening the project's international network and coordinating the assessment of the implemented tools and services. This assessment is particularly important because the increasing digitalization of research and learning is sometimes perceived as a challenge for our attention and ability to reflect (cf. [13–15]). The integrated publication system that HIRMEOS is targeting should primarily support scientific work by simplifying and accelerating basic research activities—the so-called scholarly primitives of writing, finding, commenting, referencing, evaluating, illustrating, presenting [16]—as well as elementary activities in the digital domain: searching in browsers, connecting digital texts, collecting data, scanning and creating digital texts. In order to implement services and tools for digital monographs that are geared at concrete needs and the practices of scientists and students, SUB Göttingen works to get assessments of the different interest groups on the services provided by organizing workshops and webinars with different stakeholders, as well as meetings with the editorial board of the Göttingen University Press.

3.2. From Repositories to Global Open Science Infrastructures

For about two decades now, institutional repositories have provided basic hosting infrastructure for institutional research outputs of all types. Several institutions have broadened the initial scope and created repository systems that allow distinction of parallel peer-reviewed publications and primary publications such as theses, reports or working papers and, more recently, hosting of research data and code. With the rise of integrated Current Research Information Systems (CRIS) in Northern European and increasingly Western European countries, repositories evolved from stand-alone data silos into vertically- or horizontally-integrated systems serving institutional needs, on the one hand, and researchers' needs such as publishing, discoverability and dissemination, on the other. SUB Göttingen currently runs institutional repositories along with several disciplinary repositories for the geosciences, digital humanities and for Anglo-American history and culture that reflect the historically grown research profile of the university.

In addition, SUB Göttingen works closely with the university's research department, the university's department of Strategic Development and Controlling and the Göttingen eResearch Alliance (eRA, see also Section 3.3) in building up Göttingen Research Online (GRO) as a portal for publication and research data. GRO seeks to highlight topics that Göttingen's researchers work on, where they publish and with whom they collaborate. The library's main task in GRO is the innovative publication data management system focusing on researchers' needs to curate and publish individual or group publication lists while complying with the university's institutional reporting and analytical requirements. Further integration of institutional repositories is projected for 2018 to provide full text search and access along with metadata management in one system. GRO will be integrated into the existing university's research information system FactScience to enable publication data reuse for further reporting and management purposes (e.g., performance-based resource allocation).

European open science infrastructures combine institutional and disciplinary distributed infrastructures and create overlay services that enable access to and reuse of European-funded

research outputs. Starting with the basic interoperability of repository infrastructures as created by the DRIVER projects (funded by the European Commission in the Sixth and Seventh Framework funding programs) [17], the OpenAIRE project and other initiatives have created additional functionalities, which allow for navigation along a graph of entities based on publications, research data and other research outputs, as well as research institutions and projects. In January 2018, the fourth project phase of OpenAIRE, OpenAIRE-Advance, started. The project aims to sustain the current successful infrastructure, comprised of a human network and robust technical services. OpenAIRE-Advance works towards making open science the default in Europe, reshaping the scholarly communication system towards greater openness and transparency and serving as a trusted pillar of the European Open Science Cloud (EOSC).[13] In its new phase, OpenAIRE works along the following lines (cf. Ibid.):

- Consolidate and optimize services to meet end user needs and create the European Open Science Observatory seamlessly connecting all research artifacts.
- Empower the pan-European Open Science Helpdesk network to increase its national presence and develop capacities to become a pivotal part of open science in national settings.
- Strengthen research community uptake of open science through working with three national research infrastructure nodes (ELIXIR-GR, EPOS-IT, DARIAH-DE)[14] and building bridges to key communities via an open science-as-a-service approach.
- Promote emerging changes in the scientific communication landscape and support the development of the next generation repositories with new functionalities and new technologies.
- Build a global open science network and align policies, practices and services for a truly global and interoperable scholarly commons.
- Outreach beyond researchers to lay the foundations for citizen scientists to leverage the benefits of open science and to bring OpenAIRE closer to industry through an Open Innovation program.
- Collaborate with EOSC-hub[15] towards a concrete implementation of EOSC, creating a joined-up, interoperable set of services to serve the needs of tomorrow's researcher in the context of EOSC.

Besides promoting open science at the local, national and European level, SUB Göttingen is also committed to supporting and further developing international recommendations on information infrastructures in order to align its own developments with global trends. To pursue this goal, SUB is actively involved in several national and international open science organizations and working groups (e.g., expert groups coordinated by the Association of European Research Libraries (LIBER), euroCRIS, the European Commission, Knowledge Exchange, the Research Data Alliance (RDA)).[16]

COAR, the Confederation of Open Access Repositories, is the forum of the international community for repository infrastructure, with the library being one of the founding organizations and host for the legal organization based in Göttingen. In its capacity as an international consortium and forum, COAR brings together repository partners and regional networks of repositories from around the world, including Europe, Latin America and its regional network of LA Referencia, China, Japan, Africa, Australia, Canada and the U.S. Starting with the technical interoperability of repositories [18], COAR's activities aim at the alignment of open access policies, practices, technologies

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[13] OpenAIRE, Empowering Open Science: Kick Off of the OpenAIRE-Advance H2020 project, press release, 12 January 2018, https://www.openaire.eu/empowering-open-science-kick-off-of-the-openaire-advance-h2020-project.

[14] ELIXIR Greece, a distributed infrastructure for life-science information, https://www.elixir-europe.org/about-us/who-we-are/nodes/greece; EPOS, European Research Infrastructure on Solid Earth, https://www.epos-ip.org; DARIAH-DE, Digital Research Infrastructure for the Arts and Humanities,https://de.dariah.eu/en_US.

[15] EOSC-hub, Services for the European Open Science Cloud, www.eosc-hub.eu/.

[16] LIBER Steering Committee for Research Infrastructures, http://libereurope.eu/strategy/research-infrastructures/committee; euroCRIS CRIS-IR Task Group, https://www.eurocris.org/community/taskgroups/cris-ir; Horizon 2020 Expert Group on the Future of Scholarly Publishing and Scholarly Communication, http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetail&groupID=3463; Knowledge Exchange Open Access Expert Group, http://www.knowledge-exchange.info/projects/project/open-access; RDA Libraries for Research Data Interest Group, https://www.rd-alliance.org/groups/libraries-research-data.html.

and services to avoid regional silos and to build a truly global and interoperable scholarly commons. Furthermore, COAR works on recommendations for repositories of the next generation. A recent report outlines 11 new behaviors, as well as the technologies, standards and protocols that will facilitate the development of new services on top of the global network of digital repositories, including social networking, peer review, notifications and usage assessment [19].

3.3. Research Support

Digitally-enhanced research creates new opportunities and challenges for researchers. New tools and platforms are constantly emerging that enable the collection and processing of diverse kinds of research data and other information. One core challenge is to manage and store valuable research data, in such a way that this serves both on-going research and future (re)use, including sharing with the wider research community and other interested parties. At the institutional level, this involves developing guidelines, supporting these with functional information infrastructures and equipping researchers with the skills they need to succeed in today's data-rich and data-driven environment.

To step up support for researchers at Göttingen Campus, SUB Göttingen and the computing and IT competence center GWDG have founded the Göttingen eResearch Alliance (eRA). The multidisciplinary eRA team assists researchers in e-research and data management questions throughout the whole research life cycle, offering support, consultation and training. The eRA is an integral part in the proposal submission process and, in close cooperation with the research office, provides valuable support for applicants to ensure high quality, good practices and alignment with the university's data management policy [20]. Through this process, communication between researchers and eRA is established early on, which is then maintained throughout the course of the research project. During the research phase, the eRA team offers subject-specific and individually-tailored practical workshops and training sessions on research data management. It further supports researchers in successfully implementing research data management and applying digital research methods, such as visualization. Once the project is completed, the eRA team provides researchers with information and support on persistent identifiers, publication of research papers and data and long-term archiving.

4. Analyzing Scholarly Communication

Over the last decade, the digital transformation has led to vast changes in how research is conducted and how research findings are communicated and built upon. In the context of scholarly communication and the ongoing transition to open access, research funders and institutions need to closely monitor the uptake of open access, in all its variations, and not least in terms of costs.

In Germany, the German Research Foundation (DFG) has strongly influenced how universities keep track of articles published in fully-open access journals. Through its "Open Access Publishing" program, which started in 2011, the DFG has supported more than 50 universities including the University of Göttingen to establish support structures for covering open access publication fees. These funds are often managed by the university's library. One funding requirement is the annual reporting of open access publications by researchers affiliated with the university. To comply with this requirement, SUB Göttingen uses various bibliographic data sources, such as the internal research information system maintained by the central research management units to obtain publications to which University of Göttingen researchers have contributed, and the Directory of Open Access Journals (DOAJ) to determine whether the articles were published in quality-assured fully-open access journals.

To date, SUB Göttingen manages one of the largest publication funds for open access publication fees among German universities in terms of the total number of financially supported articles reported to the Open APC initiative[17], an open data effort for sharing information about institutional spending on open access publication fees. Figure 1 shows the annual expenditure of SUB Göttingen

[17] https://github.com/OpenAPC/openapc-de.

on publication fees from 2012–2016 aggregated by publisher. While funding for open access articles increased over the period, a slight drop in 2016 can be observed because of less publications in fully-open access journals published by Springer Nature. Our future work will, therefore, focus more on analyzing the overall publication output from researchers affiliated with the University of Göttingen in order to better understand these yearly differences.

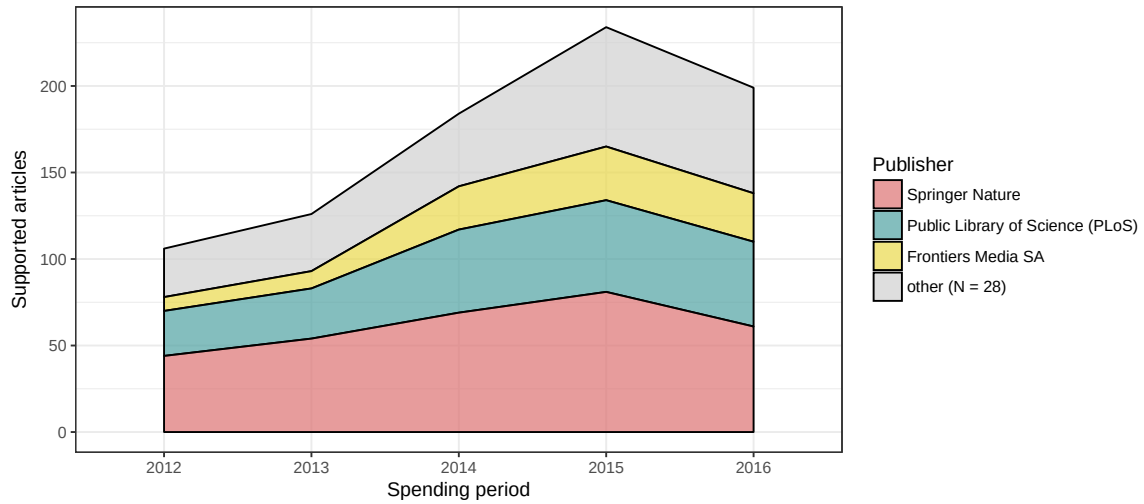

Figure 1. Articles (co-)funded by SUB Göttingen's Open Access Fund. Data source: https://github.com/openapc/openapc-de.

Our results reflect general spending patterns in Germany [21]. Contrary to findings from the U.K. or Austria, where publishing in hybrid open access journals is financially supported, as well, traditional publishing houses typically do not account for the largest share of institutional support. Rather, open access publishers such PLoS and Frontiers SA rank at the top; however, over a quarter of the expenditures was spent on Springer Nature publications, the former BioMed Central journal portfolio. In comparison, Jubb reports that more than half the expenditures on article processing charges spent by a sample of 10 U.K. universities in 2016 went to the three major publishing groups, Elsevier, Springer Nature and Wiley [22].

While reporting workflows for articles published in fully-open access journals are well-established, monitoring of hybrid open access journals remains challenging due to the lack of standardized indexing practices for hybrid open access articles in bibliographic databases [23]. In particular, in the case of hybrid open access, not all publishers share sufficient metadata to enable the identification of open access articles published in subscription-based journals, including licensing information. Moreover, self-archived copies provided by repositories are also difficult to find due to the distributed nature of repositories and the varying degrees of compliance with best-practices for tagging open access full-texts. Methods for monitoring open access to books or conference proceedings are even less established in bibliographic databases [24].

Key to improving insight into the state of open access is both comprehensive and standardized data sources and openly available tools to make the analysis and results transparent and reproducible for others. Promoting this, SUB Göttingen makes its code and, if possible, data sources openly available and actively engages in open science working groups. For instance, code libraries, which facilitate access to Europe PubMed Central [25] and Unpaywall Data [24], a DOI linking service for open access full-texts, have been developed at the SUB and were contributed to the rOpenSci initiative through its on-boarding mechanism, an open peer review process [26]. These software clients enable automated access to data sources that are instrumental for analyzing the uptake of open access, as well as for obtaining full-texts for text-mining purposes. Other examples include an easy-to-use dashboard that presents the current state of hybrid open access publishing based on openly accessible metadata

and open source software [27]. Self-organized training sessions, including a Reading Group on Data Science Literature together with other members of the Göttingen Campus complement these activities. All these activities aim at open and re-usable tools for discovering and analyzing scholarly publications, which, in turn, reduces dependences on toll-access data sources and analytical tools.

5. Transforming Acquisition Budgets from Subscriptions to Financing Open Access

One of the main strategies of SUB Göttingen to advance open science is to continuously increase open access to scientific information.[18] This involves the development and negotiation of licensing models that include open access components and the transformation of acquisition budgets by financing open access articles.

A core instrument to increase awareness and uptake of open access publishing among authors is the university's open access publication fund (cf. Section 4). While the DFG has contributed to the fund since 2012, SUB Göttingen has started to gradually move these expenses into its acquisition budget; a process that is foreseen to be finalized by 2020. Since the overall open access expenses have increased over the last five years, this is only possible through a gradual cancellation of subscriptions and the transformation of these means to open access. This process involves close alignment with faculty representatives, in particular with faculties that make use of the OA publication funds. It must however be noted that the overall direct spending on open access publication fees is still rather small, at a level of about 4.3% of the total acquisition budget in 2016 (cf. Figure 1 and SUB statistics).[19]

Additionally, researchers are expected to cover publication charges through project funding. Since some results are published only after a research project is completed, some funders offer additional post-grant funding, for example, the post-grant Open Access Pilot[20] in the European Commission's Seventh Research Framework Programme, which ended in February 2018, and the German Ministry of Education and Research's (BMBF) Open Access fund.[21]

However, the transformation of institutional acquisition budgets is mainly driven by national and international projects and initiatives. Over the last few years, transition efforts have gained momentum, but also faced several challenges. Across Europe, there are similarities, but also differences with respect to the policies and strategies in this context. A few countries strongly promote a gold open access (U.K., The Netherlands), while the rest of the EU countries support a green or combined approach [28].

In order to establish new business models and transition contracts with publishers, research and service institutions need to negotiate with publishers and convince faculties. These new transition contracts, which combine access to journal content with funding to publish in open access, inherit the risk of less flexibility and are hard to finance. The budget management within the libraries has to be adjusted, and even the role of the library might change from deciding what to buy to choosing what to publish in open access.

The German DEAL project[22] aims to conclude nationwide licensing agreements with major academic publishers. An open access component is included in these negotiations. The initiative was commissioned by the Alliance of Science Organisations in Germany, represented by the German Rectors' Conference, the HRK. Despite the effort on both sides, negotiations with Elsevier have not yet resulted in any agreement as of May 2018. Consequently, the University of Göttingen and several other institutions (overall about 200) have canceled their subscriptions for 2017 and 2018. This has taken significant pressure off tight library acquisition budgets. Currently, most universities continue to have access to formerly-subscribed Elsevier journals as the publisher seeks to show their will to cooperate. However, in case Elsevier does cut off access, those institutions in Germany that were not

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[18] Strategy SUB Göttingen 2018–2021, https://www.sub.uni-goettingen.de/en/about-us/portrait/strategy.
[19] Library statistics 2016, https://www.sub.uni-goettingen.de/en/about-us/portrait/statistics.
[20] FP7 post-grant Open Access Pilot, https://www.openaire.eu/postgrantoapilot.
[21] Bekanntmachung des BMBF, https://www.bmbf.de/foerderungen/bekanntmachung-1404.html.
[22] DEAL project, https://www.projekt-deal.de/about-deal/.

able to cancel subscriptions in the current period will continue to offer inter-library loans. This ensures access to Elsevier's papers for the time being [29] along with researcher's informal ways of getting access to material they want to read.

Agreements with Springer-Nature and Wiley are expected in 2018. If these negotiations succeed, a substantial part of acquisition budgets and scientific outputs will be transformed to open access within the time-frame of the agreements.

Open Access 2020[23], initiated by the Max Planck Digital Library, aims to replace subscription-based business models with economically sustainable and transparent open access publishing models. The national implications of Open Access 2020 are the focus of the National Open Access Contact Point (OA2020-DE)[24], which aims to enable a large-scale open access transformation of scientific journals by 2020. It is commissioned and sponsored by the Alliance of Science Organisations in Germany and collaborates closely with key stakeholders in scholarly publishing, i.e., universities, research institutions, funders, libraries and publishers, to improve the current subscription system. New open access business models are to be developed on the basis of an in-depth analysis of publications and their costs. SUB Göttingen is part of the planning and steering committee of the project.

The Deep Green project[25] focuses on so-called "alliance licenses" containing an open access clause that enables authors from authorized institutions to deposit articles that were published in such licensed journals in an open access repository of their choice with no or only a short embargo period. These licenses are negotiated on a national level and are co-funded by the DFG. SUB Göttingen supports this project in its role as one of the negotiators for alliance licenses [30,31].

Thanks to the international SCOAP3 initiative, 90% of High Energy Physics (HEP) papers are going to be published as open access articles in 2018.[26] SCOAP3 operates on an international level, while each country arranges participation in the partnership by selecting one or more national organizations as so-called representatives. The representatives then arrange the representation in SCOAP3 with all national institutions. Negotiations between the SCOAP3 consortium and scientific publishers like IOP Publishing, Springer, Elsevier, Oxford University Press and Hindawi have achieved the transformation of almost all HEP scientific journals to open access journals. If a journal covers more than one topic, only the HEP section was transformed. All publishing costs are now financed through a centrally-managed fund, such that authors do not need to worry about the financial aspect of publishing. Libraries contribute to SCOAP3 by redirecting the funds that were previously used for subscription fees of HEP literature. Today, these financial contributions correspond to the scientific output of each institution. While the costs for the University of Göttingen remained almost constant after the transition, institutions with very high scientific output face increasing financial contributions. Due to the negotiations, the average cost per open access article in SCOAP3 journals will remain at 1000 Euros maximum for the period of 2017–2019.

As a major publisher for Chemistry, the Royal Society of Chemistry (RSC) now offers an institutional licensing model called "Read and Publish". Having signed such an institutional agreement, SUB Göttingen automatically covers APCs for gold open access publications of affiliated authors in one of the RSC's hybrid journals. This licensing model serves as a pilot for new business processes for the implementation of efficient workflows for handling of these new contracts. According to the ESAC initiative[27], this includes proper author and article identification using ORCID and DOIs, funding acknowledgments and streamlining invoice and reporting processes [32].

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[23] Open Access 2020, https://oa2020.org/.
[24] The National Open Access Contact Point (OA2020-DE), http://oa2020-de.org/en/pages/about.
[25] Deep Green project, https://deepgreen.kobv.de/de/deepgreen.
[26] SCOAP3, American Physical Society (APS) to join SCOAP3 from 2018, press release, 27 April 2017, https://scoap3.org/aps_joins_scoap3.
[27] Efficiency and Standards for Article Charges (ESAC), http://esac-initiative.org.

While many of these efforts focus on providing open access to STM journal articles, SUB Göttingen also supports the production and funding of open access books. Knowledge Unlatched[28] aims at converting books and journals of renowned publishers, supported by libraries like SUB Göttingen. Librarians from SUB Göttingen accepted the invitation to join the 2018 selection committee and have have helped to choose ebooks together with colleagues around the world.

Last, but not least, the transformation to open access also depends on the authors' personal choices for publication. As it can be difficult for them to evaluate if a journal offers quality services at a reasonable price, SUB Göttingen also supports enabling services such as the Directory of Open Access Journals, which curates a list of open access journals that meet a defined set of quality standards.

6. Research and Experiments as Facilitators of Open Science

Citations (how many and by whom) as the traditional "currency" of the scientific marketplace can be complemented by other measures assessing impact and quality: peer-review, usage statistics and alternative metrics. Together with citation counts, they reflect different angles of impact of scientific outputs [33] as shown in Figure 2.

Figure 2. Four ways to measure impact.

While citation metrics have been around for several decades and are well described, widely known and used (although sometimes without considering their limitations), alternative metrics are comparatively new and still evolving rather dynamically, adding a huge number of several fast changing types of data to the research field. Yet, indicators based on interactions on social media platforms have some very attractive advantages:

- Speed: Online interactions tend to happen very fast so that indicators can be made available immediately after publication of any scientific result and its mention on a social media platform. However, the creation of such metrics requires that platforms offer an API to access and track these interactions and to map publications via unique identifiers.
- Transparency: On social media platforms used for professional purposes, it is common to act under named accounts, i.e., individuals and their activities can be identified and recognized by their peers (versus general purpose platforms that allow, for instance, anonymous comments). Consequently, this results in a transparent picture of interactions. This is also a major argument in favor of alternative metrics. Typical forms of gaming (i.e., manipulation of metrics to an individual's advantage, massively using other people to view, download or like ones' posts) can be detected more easily by software algorithms than the still common practices of citation cartels [34].
- Societal impact: In contrast to citation counts, alternative metrics have the potential to not only reflect impact within the academic community, but also within the general public. This may

[28] Knowledge Unlatched, http://www.knowledgeunlatched.org.

arguably be more or less important for some research fields, but in some, cases it would be desirable to determine where scientific findings have an impact or even improve conditions of life.

These advantages and challenges related to citation-based indicators (see also [35]) are core motivations for further investigating alternative metrics such as metrics resulting from interactions on social media platforms. The library leads the *metrics project[29], which is funded by the DFG. The project's main aim is to gain deeper understanding of less developed metrics such as alternative and more specifically social media metrics.

Together with three German partners, the project analyzes data derived from social media platforms to determine if they can be employed in the creation of useful indicators reflecting interactions with scientific outputs. Reliability, accessibility, transparency and repeatability of platforms, as well as metrics aggregators are assessed in a technical work package. Origin, disciplinary differences and perceptions by researchers of scientific communities (social sciences in general and economics more specifically) are analyzed through surveys, interviews and lab experiments. Yet, a broader range of stakeholders is invited to take part in the discussion in community workshops. The first results revealed a greater variety of platforms than anticipated, which were used by researchers in their professional lives and not limited to services targeting researchers: YouTube and LinkedIn were among the top 10 services. This broadens the potential, but also the complexity of any potential metric. Creators of interactions on these platforms exhibit different patterns (e.g., age and career level), which should be taken into account as discussed by [36]. Further research will reveal if and how scientists understand and use social media metrics, how they interpret different levels of aggregation and visualizations of metrics and how reliable different sources of alternative metrics are in practice. The project's findings will benefit a broad range of stakeholders: *metrics users (e.g., researchers, research funders), information services and libraries, but also *metrics providers, with the aim to enable informed use of these metrics and to widen our understanding of the limitations and variation in interpretation.

7. Conclusions

Much has happened since the open access movement's early days at the beginning of the millennium, when the binary model of the green or golden route for open access was promoted to revolutionize scientific communication. Free access to published results continues to play a major part, despite the fact that, for instance, rising APC prices in commercial open access journals reveal new fields of conflict. Enabled by digital technology, research data can be treated as research results in their own right, which has resulted in a need to carefully design management and infrastructure for storing and disseminating them, while at the same time calling for policies or legislation to balance diverging interests. Digital technologies in the research process allow us to conduct research on previously unattainable levels of collaboration and interaction, transparency and comprehensibility, while tenure and promotion procedures only slowly recognize these practices as relevant.

We tried to show that these profound changes on all levels of the scientific communication system do not only affect scientists or publishers, but also result in organizational changes at an infrastructure organization such as our library. In the last five years, it has led to a significant shift in competencies and skills of newly hired or existing staff, requiring them to become research partners who happen to be embedded in the library. In this article, we highlighted how we participate and contribute to various aspects of science and research, on the practical level, with training or in policy making to influence the general setting of science. Our efforts happen against the backdrop that we act on behalf of a highly diverse research campus with disciplines requiring their own research processes and publication cultures. These differences need to be taken into account, given our role to provide our different audiences with content, infrastructure and support throughout the entire lifecycle of research, regardless of the additional effort on staff to align our offers with disciplinary needs. Our efforts will

[29] MEasuring The Reliability and perceptions of Indicators for interactions with sCientific productS, http://metrics-project.net.

not lead to more uptake of open science and open access practices if our audiences find themselves outside the scope of our consideration.

Besides our library efforts, further uptake of open science requires a gradual but profound shift of mindsets and social practice, and we anticipate this shift to continue for many more years or decades until it becomes mainstream. Our participation in the described projects leads to quantitative and qualitative growth of activities and staff, but is often based on third-party funding that we have to win in competitive settings. The activation energy from such third-party funds helps us enormously to set up services, but does not solve the challenge to run and extend them in a sustainable fashion and reliably accompany the lengthy shift of mindsets and paradigms. When we started our electronic publishing services around 2003, it was mainly on project money and prototyping services and exploration of whether there would be enough demand to transform them into permanent offers. While this is an understandable management decision, it poses the challenge that, on the one hand, preliminary services create as much or even more effort than routine services and, on the other hand, that services with transformative potential such as open science need time to gain recognition and acceptance.

Libraries are considered to be long-standing partners that are here to stay, and only against this backdrop are we able to reach out to scientists and act as a reliable partner in these newer fields that to many of them seem fast-changing and not yet established. We consider the following activity as our most promising and important. That is, building an open science network together with early career researchers through our Göttingen Open Science meet-ups has been an inspiring experience and has helped to step up knowledge and resulted in new types of collaboration. Making our colleagues from the more traditional parts of a research library aware that supporting open science is not the folly of the few, but the necessary progress we all have to make, has its difficulties. We believe that offering training on open science in-house and at library conferences is a way of sharing our experiences with our direct library colleagues and communities that helps them to come along on the way (plus learn new and exciting things). To end on a positive note, we have taken a broad and inclusive perspective to foster engagement in bringing forward open access and open science at the University of Göttingen. It is therefore the goal for the next few years to further strengthen the local implementation through local, national and international activities, to ensure a smooth shift of core library service areas and to foster and support good open science practices at Göttingen Campus. We are convinced that research libraries like ours are well-fitted hubs for open science activities, able to bridge status groups or disciplinary boundaries and unlock the full social potential of open science.

Author Contributions: All authors contributed to the writing of the paper. B.S. managed the author collective, coordinated the writing and edited the first version of the paper. A.B. organized editing of the revised version and made us all comply with the reviewers' requests.

Acknowledgments: The following projects are related to this work: the EU-funded projects FOSTER Plus, 741839; HIRMEOS, 731102; OpenAIRE2020, 643410; and the German Research Foundation-funded *metrics project. We thank our international and local colleagues in libraries and research for ideas and inspiration, Daniel Bangert for the final language check and last, but not least, our reviewers for their valuable input to improve the article.

Conflicts of Interest: The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses or interpretation of data; in the writing of the manuscript; nor in the decision to publish the results.

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