

Inside the Laboratory: Open Science and the Skills of Research Librarians

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Introduction

The historical course of the opening of science is a long and ongoing process that entails one of the strongest devices of modernity in the form that emerged from the seventeenth-century Scientific Revolution. Libraries are committed to scientific endeavor since immemorial times. As the human element of social constructions designed to make information available and to archive research outputs, librarians worked side-by-side with science development, researchers, and their information needs. While not new, this partnership is evolving in new directions, necessitating a new skill set for library professionals.

The purpose of this chapter is to analyze the current changing process of science and its impact on the skills of research librarians. A literature review reveals the relationship between librarians and science openness. Although libraries remain at the core of the scientific process, they lost the monopoly of information provision and their traditional roles in science production and dissemination are now questionable. Library and information science practitioners are facing a set of relevant challenges. Librarians are strongly involved in the future of science as an important system stakeholder as well as a provider of information products and services. Also, librarians must expand their traditional skills to be able to respond to the current needs of researchers, and the openness demands emerging from society. Are research librarians prepared to take part in Open Science? What is their current position? Is there a need for a new librarian skill set?

Literature Review

Searching the *Web of Science* Core Collection and Elsevier's *Scopus* database yielded relevant articles examining the relationship of Open Science and librarians' skills. *Google*

Scholar data provided another avenue to examine this relationship. Initially for both searches, I used the publication year date range of 2000-2019. To assist in narrowing both searches and reducing the number of articles retrieved, I limited the publication year range to 2018-2019. The *Web of Science* and *Scopus* searches yielded a net of 11 and 10 papers each. The Google Scholar searching yielded a net of 24 papers. The integration of the 35 papers revealed the existence of eight duplicated records. To keep up the homogeneity of the sample, the final list of papers excluded five 2015 papers retrieved from the *Web of Science*, resulting in a set of 22 papers published between 2018 and 2019. The full-text reading resulted in the exclusion of four papers as not relevant to goals of this chapter. After making some further adjustments, the final number of papers examined totaled 23.

Libraries have been involved in science openness since the origins of the Open Access (OA) movement. *The Budapest Open Access Initiative* (14-02-2002) started point for a worldwide campaign and discussion around OA and greatly impact libraries' positioning. In 2003, the *Bethesda Statement on Open Access Publishing* (20-06-2003) focused on scientific publishing and included a section dedicated to the proposals presented by libraries, which highlighted the support for the OA editions and the users' training on OA publications' advantages. In the same year, the *Berlin Declaration on Open Access to Knowledge in the Sciences and Humanities* (22-10-2003) referred to libraries as one of the actors involved in creating a global platform of scientific and human knowledge.

Peter Suber, one of the most prominent OA activists, established a definition to coordinate the three declarations (Budapest, Bethesda, and Berlin) proposing that "OA content must be free of charge for all users with an internet connection" advocating "users permission for all legitimate scholarly uses" (Suber 2004). Suber also defined OA in this synthetic way: "Open access literature is digital, online, free of charge, and free of most copyright and licensing restrictions" (Suber 2012, 4). As information gatekeepers for several

decades, libraries are seriously weakened by the overall price rises of scientific literature, and their roles needed to be redefined as information facilitators and OA promoters (Calarco et al. 2016).

The impulse of the OA movement largely shaped Open Science initiatives (Guédon 2006). Since their historical origins, civil organizations, professional and scientific associations, universities, and non-profit organizations pushed for the opening of science. (David 2008). This opening movement created the process of acceleration with the development of digital networks, which increased the information flow speed and the researchers' ability to reach larger audiences (Bartling and Friesike 2014). Among the various definitions for Open Science, there is a threefold perspective: gathering open research data, open access to publications, and communication of scientific outputs (The Royal Society 2012). As libraries become one node in the large network that supports the information infrastructure, they become less visible for users, funders, and policymakers. Recent studies identified a decline in physical visits to libraries (Nicholas et al. 2018), although libraries have sought to provide differentiated spaces for researchers as well as other services that seek to respond to all stages of the scientific research cycle (Atkinson 2016). Borgman (2003) discussed this paradox between the physical world of information and the growing penetration of digital technologies that increasingly dismisses the physical presence of users in the library space. This paradox lies in the heart of Open Science unresolved issues, as the barriers' removal may also modify libraries' usefulness. The loss of the information monopoly place libraries in a highly competitive environment, with multiple sources of information, and where libraries seek to expand their products and services' portfolio to be able to survive. Researchers' perception of the academic and research librarians' ability to participate in research is limited to knowledge organization and access, as the remaining stages of the research cycle are under the control of researchers (Research Information Network 2010).

Investing in services for researchers could decrease libraries' activities among students. It might also be problematic to step out of the comfort zone and embrace the embedding of librarians in research teams (Atkinson 2016).

The changes in scientific communication had led librarians to reorganize services to be more active in supporting researchers (Brantley, Bruns, and Duffin 2017). A physical transformation of the spaces has begun, and a change in the way these libraries have supported research beyond collection building (Anglada 2014). This has created new fields of professional activity promoting OA, maintaining institutional repositories, helping researchers to make their work visible on the Web and facilitating the adoption of author and documents identifiers. After all, these new services reacted to an increasingly competitive information environment (Vandegrift 2018).

Nevertheless, the literature reveals a conflict between traditional roles and new demands. Once “a repository of data, information and knowledge and a source of expertise in helping scholars access them”, libraries and librarians are facing a new setting in which the “processes and the skills that are required to fulfill the same function are fundamentally different. They should be those for a world in which science literature is online, all the data is online, where the two interoperate, and where scholars and researchers are supported to work efficiently in it” (The Royal Society 2012, 63). Universities, as producers and consumers, are now part of an emerging networked information system where libraries take part as embedded structures of cooperation (Pinfield, Cox, and Rutter 2017). The main change is the enlargement of traditional library functions to achieve collaboration within academy (Luce 2008). Three key roles must be found in this transition: support to the early stages of knowledge creation, including research data management plans (Heidorn 2011; Schmidt and Shearer 2016); development of collaboration infrastructures between scientific communities; and research data curatorship. All these aspects led the library to gaining a laboratory status,

moving away from the idea of a warehouse or silo of information (Gold 2007). Although OA seems to reduce the importance of libraries in institutional collections' development, librarians' skills remain essential for repositories' management, for metadata structures that maintain information retrieval capabilities in OA, and for the mechanisms of resources' preservation (Harris 2012). If the future is through collaboration and sharing of resources, the main change will be the shift of importance from the library to the librarian: "the information professional is the library of the future" (Harris 2012, 14).

One of the most significant shifts concerning the new roles that libraries assumed (Koltay 2016; Cox 2016) is the proposal to embed librarians in the research life cycle (Vaughan et al. 2013; LIBER 2018), making them partners of researchers. In the digital environment, librarians have the opportunity to integrate more actively in the process of knowledge creation (Lincoln 2010). Their contribution is not only the replication of the earlier roles of information organization, but also the core of values (access, preservation, and ethics) that the professional community transports in its work. Indeed, librarians are called into action because "embedding academic librarians fully into the research enterprise recognizes the significant contributions that librarians can make as research partners" (Monroe-Gulick, O'Brien, and White 2013, 382). Open Science demands a new set of competencies and training courses both for librarians and researchers (Working Group on Education and Skills under Open Science 2017). One of the most active European Commission-funded projects in recent years in Open Science, particularly in training researchers and librarians, is FOSTER - Facilitate Open Science Training for European Research (started in 2014) and FOSTER Plus (started in 2017).

Being embedded in the research life cycle guarantees the sustainability of research libraries in Open Science transformation. Consequently, there is a cultural shift from the concept of 'support' or 'collaboration' to the concept of 'partnership' (Kingsley 2017).

Libraries assumed leadership roles to ‘break’ and ‘open’ the whole cycle of research. Although the ‘monopoly’ of information and the ‘ownership’ of collections are lost, it is now time to re-take responsibility for the preservation of digital objects, which are scattered on the servers of commercial publishers (Lynch 2017). In the deadlock between the lack of relevance and their comfort zone, librarians have a reduced set of options. Embedding librarians represent a profound conceptual change since they are intended to take an active stance towards the communities and organizations served (Carlson and Kneale 2011; Shumaker 2012). It is urgent to redefine the professional profiles, the training provided, and the professional recognition of these new competencies and new roles that derive from the traditional profile (Brewerton 2012). Berg and Banks (2016) stressed that librarians should develop research skills, to acknowledge researchers’ difficulties . This could facilitate the immersion on research issues, both in scientific publishing and co-creation as well, with the active participation of librarians in partnership with researchers (Borrego, Ardanuy, and Urbano 2018). In Open Science context, the transition from being a traditional librarian to a new role, such as a data librarian, involves not only new skills’ acquisition but an in-depth knowledge of the research process, to be able to participate as a full partner in an open life cycle (Brown, Wolski, and Richardson 2015).

Current Skills

Are Open Science dynamics having an impact on the skill set of librarians? Do librarians need to change their skills to take part in the process of opening science? With these questions in mind, the author conducted a current literature analysis to investigate one of the layers involved in this complex transition: librarians and their skills. As Schmidt et al. (2018) alerted: “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” (1). The Open Science

transition reveals a new set of terms to describe libraries' active roles, like provider, partner, and pioneer: "Libraries are looking for ways of furthering this transition through the creation of dedicated digital scholarship spaces, teams, and resources, as catalysts for increased collaboration" (Greenhall 2019, 5).

The activities and roles of academic and research librarians expanded in recent years. Suri (2018) listed several areas of activity including teaching & education support, promotion & advocacy, communication & liaison, and personal development. Ogunbeni et al. (2018) affirm that "academic librarianship has developed into a distinct profession with its own set of ideals, objectives, and commitments within the academic community" (114). Optimistically, the authors foresee libraries as key partners for the long-term future of Open Science. In fact, to achieve this ideal place, library teams would need training, continuous professional education, and probably re-staffing (Schmidt et al. 2018).

None of the current changes affecting scholarly communication and the research landscape "are beyond the reach of librarians' core skills, as long as there is sufficient support for continuing education and concentration on new roles" (Glusker and Exner 2018, 103). Librarians have at their disposal the essential foundations to welcome newer modes of research support as "digitization, metadata creation, scholarly communications, and data management provide specialized direction to these traditional skills, while fundamentally building on the basic information and documentation principles on which librarians have always relied" (Glusker and Exner 2018, 103–4). Particularly the new data material, and its unstructured nature, presents several issues to librarians' traditional mindset.

This analysis focuses on the first pillar included in "the general framework of preparing any institution (including libraries) to become part of the transition to Open Science": "Build the right skills in your staff; Develop or adopt a toolkit that will help you in the practical aspects of managing the transition; Make a good plan and act with discipline to

achieve your goals; Develop and act with a sense of leadership; make sure you lead the change and not just follow external changes” (Ayris and Ignat 2018, 18). Leaving the comfort zone is often referred to as mandatory for the expansion of librarians’ roles and skills, although library and information science undergraduates with a humanities background did show difficulties in assuming a more technological or specialist set of functions (Haglund, Roos, and Wallgren-Björk 2018). The destination is the embeddedness of librarians in the research teams, in close relation with different stages of research life cycle (Glusker and Exner 2018). Below we outline nine skill areas based on the latest literature.

Research Data Management Skills

One of the essential aspects of the new librarians’ skill set is related to the development of research data management. In the context of Big Data (Zhan and Widén 2019), Open Science emerges mainly in the data-intensive environment in which institutions and researchers need to access, manage, and disseminate research data. In face of “skepticism of the value of research to inform popular opinion” librarians are reminded “of their critical role to ensure access to authoritative information, and preserve research output and the cultural record (...) inspiring strategies for the social good through fostering collaborations such as open science” (Nitecki and Davis 2017, 1–2).

Data librarianship emerges as a new professional field which implies new skills and specific training to provide “data support services, including instruction and training, data management planning guidance, data stewardship and curation, and data visualization” (Federer 2018, 294). Although some literature refers to research data not mentioning the Open Science issues, Open Data is one of its pillars. Training librarians for data management is closely related to many funders’ mandates, which demand not only free access to publications but also research data mandatory availability. However, the addition of data services to libraries’ portfolio was not a smooth operation. As “it takes institutional support, staffing, and

budget to move into offering data services as part of research support”, “many libraries and librarians have had to create those offerings without the requisite support, staff or funds, and it creates intense pressures, especially on those staff with more data-friendly skills and proclivities, if specialized staff are not hired” (Glusker and Exner 2018, 104). Kupriené and Petrauskiené (2018) recommended that “libraries should have data-savvy librarians who have knowledge of datasets, understand technical issues and techniques, and have multi-disciplinary competences. Moreover, some of them should have technical data mining and analysis skills that allow them to work with data, to automate workflow and to be fully integrated into research teams” (7).

Regarding the professional identity of data curators and the pressure to increase access and preservation of research data caused by the Open Science movement, Tammaro et al. (2019) broadly presented the skills in managing and curating data. The skills needed for the new data curation positions are diverse, not only technological, managing and archiving data, but also social or soft, involving community building and outreach and training which “require good communication, instructional, and presentation skills” (Tammaro et al. 2019, 101). A blended set of librarianship and computer programming is required. Knowledge of metadata standards, data formats, data curation technologies, information security, and data protection law is combined with the ability to develop collaborative relationships and to establish trust with the researchers. However, the authors stressed that “the lack of technical skills and hands-on experience, with databases and scripting” is pointed out by qualified librarians, in contrast with the lack of “knowledge of the library metadata standards and structures for organizing information” mentioned by data curators with no library and information science qualifications (Tammaro et al. 2019, 102). Above this divergence stand out the lack of knowledge about research methods and the research process itself. Research

background becomes an essential skill for data curators, enabling conversation between researchers and information professionals.

Data management is essential for science reproducibility and this goal might provide a rationale for new library services as librarians could contribute to active research data management “helping researchers manage their data during the research process itself, not just during planning or depositing final data in repositories” (Sayre and Riegelman 2019, 268). This life cycle intervention poses new demands such as organizing research output, applying new forms of information organization, enabling communication and collaboration between researchers, and complying with funders’ requirements for data management implementation to advance Open Science (Nitecki and Davis 2017). Consequently, a different pace of libraries’ adoption of data management is expected. Regarding citizen science, another important issue of Open Science, some authors mentioned the increasing involvement of libraries in the task of bringing together scientists and researchers (Kuprienė and Petrauskienė 2018). Libraries should “contribute to FAIR [Findable, Accessible, Interoperable and Reusable] data and develop collections of such data. Citizen science projects generate data and libraries’ support in this matter is much needed” (Ayrís and Ignat 2018, 19).

Research data management often need the work of a multidisciplinary team and libraries should be a motivated and active partner. Schmidt et al. (2018) described the work of one of these teams, underlining the importance of the establishment of early communication with researchers and its maintenance throughout the research life cycle, including “subject-specific and individually-tailored practical workshops and training sessions on research data management” (11). Collaboration and support are key to Open Science success. At the University of Florida, librarians created a new research support service to assist academic community with their data management needs, bringing together several campus units (Smith, Gonzalez, and Bossart 2018).

In synthesis, and according to Nitecki and Davis's proposal (2017), the essential skills to support research data management are knowledge of the research life cycle, data infrastructures, new forms of data review and citation, data archival services, repositories trustworthiness, design of workspaces for researchers, intellectual property rights, compliance, and regulations regarding research data, data mining, and analytics application.

Data Science and Visualization Skills

Data Science is an interdisciplinary field of statistics and computer science applications. Open Science and Open Data, as data-intensive proposals, are also contributing to the development of Data Science. Academic libraries are providing guidance in some universities, thriving to support researchers and training on the required specialized skills. Data Science support demands the expansion of librarians' expertise by the acquisition of new skills and often the recruitment of additional library staff, with special focus on computational literacy, geographic information systems, and reproducible science. Learning Python or R programming languages is surely a challenge for librarians with a traditional background qualification, but there are more often programs with a Data Science specialization (Oliver et al. 2019). This area is still new in libraries' services portfolio. Librarians could help researchers in this communication skill and "at a minimum, should continue to act as networking hubs to connect researchers with other resources on campus that can assist them, ranging from informatics or communications departments to statistical support" (Hunt and Bakker 2018, 193).

Training Skills

Libraries integrated Open Science into their instruction programs as a subject for the training of researchers, particularly information on OA. Previous approaches "failed to recognize that many scientists are not aware of what open access is, how it affects them and why they should deal with it. In brief, there was a lack of scientific context. A separate

training course entitled “Open Access” is therefore unattractive for scientists and does not explain the benefits for them because it is not related to the research circle” (Arndt and Frick 2018, 3). Redesigned recently, these programs “expand the range of training courses in the field of open access in order to close the existing gaps, to reduce the individual support effort, to link the term open access to the research cycle and to impart the most important competences in the field of scientific publishing” (Arndt and Frick 2018, 3). This German example found a connection between trainers’ professional experience and the courses assigned to them, e.g. a librarian responsible for processing publication fees conducted a ‘Publication Fees’ course.

The promotion of Open Science requires an improving comprehension of publication structures. In a US example, the education of researchers about dissemination, negotiation, and copyright issues is considered a responsibility of libraries: “this includes providing expertise in understanding publication agreements, author addenda, institutional open access policies, and copyright and fair use. Broader dissemination encourages greater transparency and a more robust scholarly discussion, and, as such, increasing understanding of author rights and sharing options can inspire researchers to further facilitate open science” (Hunt and Bakker 2018, 193).

Librarians are summoned to develop their training skills. In Portugal, Sanches (2019) described a case study regarding an academic library’s training program and pedagogical role which “seeks to advocate for Open Science, giving the teachers and researchers greater confidence by promoting transversal competences, which facilitate greater participation in the global dissemination of scientific knowledge” (463). The focus on information literacy skills’ development demands that librarians acquire training skills compliant with the Open Science requirements. Across Europe in 2019, the Digital Skills for Library Staff and Researchers LIBER Working Group, <https://doi.org/10.5281/zenodo.3251731>, started the mapping of

Open Science training programs relying on skills identification. This work will generate cartography of experiences on Open Science skilling and training in both libraries' and researchers' communities.

Marketing skills

The use of marketing techniques by librarians is a key component to reach researchers and enable collaboration. Hunt and Bakker (2018) state that customized strategies could promote better engagement. Regarding the Open Access International Week experience, a German case reported several marketing activities (e-mails, flyers, posters) and a communication strategy definition. This dimension is considered critical to achieving scientists' enrolment and the research institutions leaders' adhesion to the effort of libraries. This example also shows the need for customized strategies and tailored discipline-based materials (Arndt and Frick 2018). The library evolved into an innovation driver, increased its reputation, and contributed to OA institutional rate increase.

Publishing skills

Beyond the traditional curator's role, librarians transformed into active disseminators of research outputs. In a United Kingdom (UK) example, Ayris and Ignat reported the creation of UCL Press by UCL Library Services (University College London), the UK's first OA university press. UCL created the service in 2015 as "a response to the challenge which Open Access presents to authors". Becoming "an active creator of knowledge", this publishing experience surpassed librarian's role as "a curator and cataloguer of knowledge" (Ayris and Ignat 2018, 9–10). Glusker and Exner (2018) state that "many libraries are now hosting journals on their institutional repository or other open access systems, and managing the infrastructure for faculty to conduct peer review and editorial tasks in order to publish journals" (103). In Germany, "the university library runs Göttingen University Press (GUP) to offer reliable and affordable publishing options for Göttingen authors. (...) 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" (Schmidt et al. 2018, 7). In Zimbabwe, Tapfuma and Hoskins (2019) found that many librarians do not have a qualification in publishing. In fact, "possession of knowledge and skills of publishing would be an added advantage to Institutional Repositories maintainers and developers as they would understand the nature of scholarly publications and the publishing behaviours of authors". As a "drawback to active participation in knowledge production and dissemination in the institutions", the authors recommend that university libraries should send their staff for training to be active partners in the opening of science (Tapfuma and Hoskins 2019, 411).

Bibliometric Skills

Although not a new field, librarians could have a leadership role on bibliometric activities. Ayris and Ignat (2018) emphasized that University College London Library is doing this: "the University Bibliometrics Working Group is working on a University Bibliometrics policy – one which acknowledges DORA (the San Francisco Declaration on Research Assessment) and establishes new norms for evaluation and metrics" (20).

Advocacy Skills

Open Science has a deep message within, with economic and political implications. Since its origins, librarians' involvement in the dissemination of this message had a close relationship with professional standards, ethics obligations, and foundational values of the profession, such as the freedom to information access. To contribute to science opening, librarians developed advocacy skills. Ayris and Ignat (2018) referred that "Open Science activity is supported by 3 enabling actions performed by the Library – advocacy, relevant strategy development, and Open Access activity as the default" (21). After the infrastructural period, which began with the OA movement and mainly focused on building institutional

repositories, “academic libraries need to be involved more in advocacy, to encourage scientists and other stake holders in the scientific research process who are skeptical about open science to join the movement” (Ogunbeni et al. 2018, 119).

Leadership skills

Research data management and other activities are opportunities for libraries to assume a leadership role which “requires self-motivated, research-grounded, intellectual entrepreneurs” (Nitecki and Davis 2017, 5). Ayris and Ignat (2018) insisted that libraries could offer program leadership in several areas of Open Science activities. Data management and data policy compliance, for example, demands a high-level of coordination, and libraries could stand for an institution-wide leadership role (Hunt and Bakker 2018). Other authors mentioned that the Vilnius University Library took the leading role in opening science by providing strategic insights and solutions for the development of services in Lithuania, particularly “coordinating the implementation of data management policies and procedures in institutions, in close cooperation with other institutional units (e.g. science administrators, IT staff, lawyers, etc.)” (Kuprienė and Petrauskienė 2018, 6). Another field of action is reproducible research, an essential element for Open Science implementation. Sayre and Riegelman (2018) foresaw a leadership role for academic libraries as “one of the few organizations within an academic institution that has the expertise and infrastructure to broadly support reproducible research” (5).

Communication, Interpersonal, and Networking Skills

The literature underlines how important is the personal connection established between librarians and researchers. Federer (2018) noted that data librarians declare “Personal Attributes” as the most highly rated category overall. In contrast, “Library Skills” ranked as the lowest rated category. Federer lists the top five items overall as “Developing relationships with researchers, faculty, etc.”; “Oral communication and presentation skills”; “Teamwork

and interpersonal skills”; “Written communication skills”; and “One-on-one consultation or instruction” (297). These relationship skills include collaboration with researchers, as “librarians can provide valuable partnerships by bridging multiple disciplines through the interdisciplinary information perspective”. However, the researchers’ lack of awareness of library services, as a barrier strengthened by the decrease of library’s spaces and physical resources’ use, “intensifies the pressures on libraries and librarians to increase and focus outreach and instruction efforts. The liaison model that has served us for decades can evolve to include research, but may need to be continually revisited and reworked” (Glusker and Exner 2018, 105). In the connection between funding and interdisciplinary collaboration, Hunt and Bakker (2018) found that “the library is an institutional hub for information, and liaison librarians who have personal connections across the university are particularly well positioned to assist in making networking connections” (194). The dissemination of information about OA services and current Open Science activities could be made “via direct communication with researchers or research support staff, as well as through mailing lists” or through the organization of “events such as roadshows, hands-on workshops or low-threshold events, e.g., our Open Coffee Lectures to reach walk-in audiences” (Schmidt et al. 2018, 5).

Conclusion

The nine areas of skills outlined from the current literature show how librarians are embracing the transition from a traditional profile to new modes of engagement and connection with research endeavor. Open Science is, therefore, an opportunity for professional development and interdisciplinary and intra-institutional intercourse. The connection of librarians to the different stages of the research life cycle is the utmost theme among the literature, while research data surpasses all the other information resources studied. Librarians have large experience with literature retrieval, bibliometrics, data management, scholarly communication, and subject-related services. Some librarians also support today

computationally intensive research. However, these advantages must be complemented by "expertise in how the disciplines they support define reproducibility, the disciplinary norms regarding transparency, and the methods used in these disciplines" (Sayre and Riegelman 2018, 6). The acknowledgment of the discipline-based most pressing issues is critical to librarians' value-added contribution.

In the complex landscape of research and academic institutions, librarians are exploring new ways to foster collaboration and partnership. In some cases, libraries are moving fast along Open Science challenges, while scarce resources or different policies are taking other libraries in the opposite direction. The loss of information monopoly and the pervasive nature of digital technologies are here to stay, and librarian's teams need to cope with the novel setting through skills development or re-staffing. The expansion of library services' portfolio lead to the positioning of libraries as an essential part of the continuing openness of science, since many of the new emerging roles and services are intended to collaborate in this process, defending some basic principles and values that form a positive discourse on Open Science (Ogungbeni et al. 2018).

Thus, it can be said that the opening of science is also a task of academic and research librarians, particularly given that there is a global demand for greater collaboration and transparency among all players in the system. At the same time, such openness is also profoundly changing librarians' skill set. One of the strongest implications of these results is in curricular design for library and information science schools. The traditional syllabus must be combined with the challenges brought by Open Science, to create flexible professional profiles able to answer society's demands for research transparency. Universities must also be prepared to foster continuous professional development and support librarians in their responsiveness to new demands.

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