Article

The roles of academic libraries in propagating open science: A qualitative literature review

Information Development
2018, Vol. 34(2) 113–121

DOI: 10.1177/0266666916678444
journals.sagepub.com/home/idv
SAGE

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Abstract

This study investigates the roles of academic libraries in propagating Open Science. The study is a qualitative survey based on literature review. Various definitions of open science from different scholars and schools of thought were examined. Research articles on the effects of open science on research and the place of academic libraries in scientific research were reviewed. Open science enhances collaborations and sharing of resources among researchers. Metadata related activities are more prevalent due to open science. Open science has increased the relevance of science to our environment and world issues like privacy and the rightful author of scientific data are still some of the challenges facing open science. Academic libraries continue to take steps to be involved as key players in the propagation of open science through advocacy, building of institutional data repositories and serving as hubs for scientific collaboration among others. Academic libraries have to do more in the area of advocacy and provision of data repositories.

Keywords

academic libraries, open science, open access, open source, scientific research, scientific data

Submitted: 13 July, 2016; Accepted: 18 October, 2016.

Academic libraries need to encourage those who are skeptical about open science to join the movement.

Introduction

There is a growing movement of the process of research in science and science-related disciplines called Open Science (David, 2004). Open science is itself an offshoot of open source and open access. Though there are different schools of thought on the concept of Open Science, most scholars agree that it is prompting major modifications to research practices and journal articles. These modifications reflect a concerted bid to increase the cumulative nature and validity of published findings so as to have a better understanding of science and its associated disciplines. David (2004) asserts that open science will bring a major revolution in scientific research and scientific data, transparent analysis and reporting of

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studies and more open sharing of experimental materials and raw data. But before this can be actualised, there is a need for more awareness and better understanding among researchers about the meaning and advantages of open science. Researchers need to know that the response to the restrictions placed on the sharing and exchange of software codes, research data and research publications through proprietary access, which consequently have placed many of them in obscurity, is open science.

With the incursion of social media into the publication and promotion of research and the use of altmetrics in measuring research impacts, researchers will be doing themselves more harm than good by sticking to the old 'traditional' method of publishing the outcome of scientific research. One of the fears of those who are sceptical about open science is that they may be seen to be engaging in questionable research practices. Nevertheless, open science can foster information and knowledge sharing within research, educational, and scientific communities in traditionally economically disadvantaged regions.

The role of the academic library has evolved as the priorities of academic institutions have evolved. At the same time, academic librarianship has developed into a distinct profession with its own set of ideals, objectives, and commitments within the academic community. Academic libraries will be key partners for the long-term future of open science, as they are in the best position to take a broad view of what their patrons want. Over the years, the relationship between open science and academic libraries has deepened significantly and continues to grow. This study looks at scholarly works on open science with a view to outlining ways of improving the relationship between the library and open science.

Statement of the problem

Academic libraries play a pivotal role in promoting research at all levels. According to Wigboldus and Dotsch (2015), open science has been one of the criteria used by academic libraries to promote research through making publications available to the public. It provides the opportunity for research publications, research data and methods used in research to be published openly and used by all. This has a significant impact on the work academic libraries do to satisfy the information needs of their customers. ''Three aspects are particularly important to academic libraries: their role in open publishing, the impact of openness on their collections and information service work, and the rise of research data and methods as information materials alongside publications'' (Keskatilo, 2015: p.5). Academic libraries have invested a great deal of work in promoting openness, particularly in relation to Open Access publications (Ogungbeni et al., 2015). But in spite of all the effort that academic libraries have invested in support of open science, its impact is still invisible.

Aim and objectives

The aim of this study is to identify the roles of academic libraries in propagating open science. The specific objectives are to:

(i) identify the concept of open science and its benefits to scientific research
(ii) investigate the challenges of open science
(iii) examine the roles of academic library in scientific research
(iv) find out how academic libraries can maximize the benefits of open science.

Significance of the study

This study will benefit stakeholders within and outside the academic world. Scientific researchers and academic librarians will have a better understanding of the benefits of open science to the field of research. This study will help scientists to know how to overcome the challenges of open science. Librarians will come to appreciate their relevance within academic institutions and how other stakeholders look to them to provide them with the information they need, helping them to be more visible and helping the institution to be highly rated. This study will be useful as a frontier of knowledge for young researchers interested in the area of open science, open access and open source.

Methodology

This study is a qualitative survey based on literature review. Online academic databases such as SAGE, ERIC, ProQuest and Elsevier were searched to retrieve relevant articles. Search engines such as Google, MSN and Google Scholar were also used to search for information. Search terms used include: 'open science'; 'open data'; 'scientific research'; 'academic library and research'; 'roles of academic library in research'; and 'collaboration between

academic librarians and scientific researchers'. The searches were conducted between 10th and 31st March, 2016. A total of 52 journal articles were retrieved, of which 34 were found to be relevant. A total of 4 monographs on the topic of study were also relevant.

Literature review

Open science: concept and definition

The digital age is a baby of science, but since the World Wide Web went public about 25 years ago, science has not only struggled to go digital but also struggled to be opened. Open science is the practice in science and science-related disciplines of making scientific data, lab notes and other information of scientific research available for the purpose of sharing, re-use, redistribution and reproduction through collaboration among researchers (European Union, 2015). Open science advocates that the formerly hidden scientific process be made public to both amateurs and professionals in the field of scientific research (David, 2004).

According to Wikipedia (2016), the clamour for open science began in the 17th century with the advent of the academic journal, when the societal demand for access to scientific knowledge reached a point where it became necessary for groups of scientists to share resources with each other so that they could collectively do their work. The practice of open science is hinged on the theory of verifiability based on Popper's (2002) asymmetry. As systems become more complex and the data sets too large to reproduce, calculations that are verifiable in principle are no longer verifiable in practice without public access to the code (or data). According to Gezelter (2014), ''if we really want to allow skeptics to test our claims, we must allow them to see the workings of the source code, lab notes and research data that were used''. This is supported by the open science movement. The open science movement broadly states that science must be done in an open and reproducible fashion where all components of research are open.

There are various schools of thought concerning open science. Fecher and Friesike (2014) identified five schools of thought based on their assumption, goal and keywords. These are; pragmatic, infrastructure, public, democratic and measurement (Figure 1).

The diversity, and perhaps the ambiguity, of the various schools of thought are, however, understandable considering the difference in the nature of the stakeholders directly affected by the changing scientific environment. These are in the first place, researchers from all fields, policy makers, platform programmers and operators, publishers, and the interested public. It appears that each peer group in discussing the term has a different understanding of the meaning and application of open science. A critical look at the opinions of the various schools of thoughts will, however, show that they all agree that scientific research should embrace the principle of open source and open access.

The effects of open science on scientific research

The advent of open science has made science to be more relevant to our environment and our world. According to the European Union (2015), the increasing importance of open access principles and policies has been stressed in the context of the Digital Single Market strategy, whereby optimal circulation and transfer of scientific knowledge vis-à-vis open science will contribute to increased innovation, jobs and growth in the European Union (EU).

The positive effects of open science on scientific research, according to Fecher and Friesike (2014), include; making science understandable, making research products available, making research more efficient, finding alternative measurements for scientific research, and encouraging social and collaborative networks. In advocating for new ways of writing research findings, Cribb and Sari (2010: p.15) stated: ''Science is by nature complicated, making it more important, good science writing should be simple, clean and clear''. As the scientific audience becomes broader and the topics more specific, the academic dissemination of knowledge need to be flexible.

In making research more efficient, there is a close relationship between open science and open innovation. Tacke (2010), for instance, built upon the connection between the two (open innovation and open science). Tacke regards Web 2.0 in this regard as a profitable ground for practicing collaborative research, and emphasizes the 'wisdom of the crowds' as a necessity in solving today's scientific problems.

Open science is encouraging alternative measurements for scientific research. Today there are various alternative citation metrics (altmetrics) for measuring impact of scientific publications. Advocates of the open science measurement school express the following concerns about the 'traditional' citation metrics for determining impact factor: they require a time-

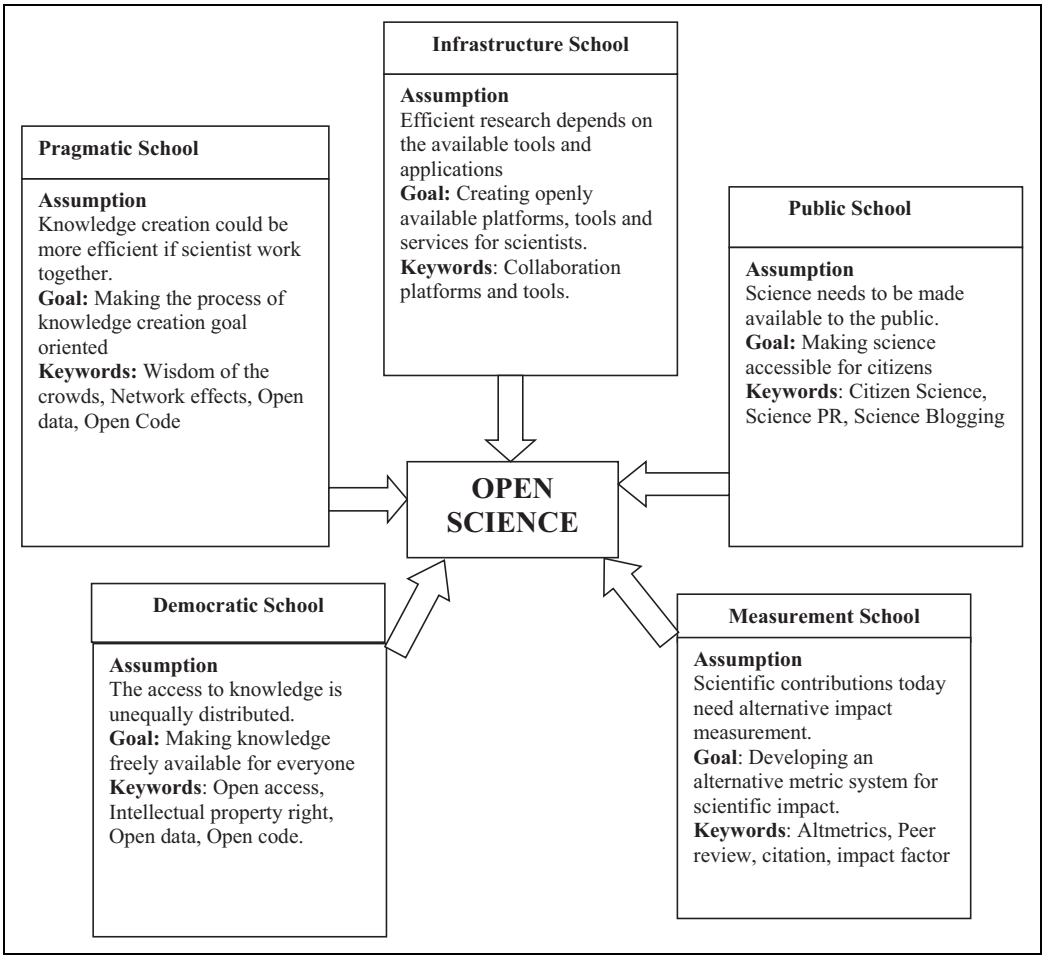

Figure 1. Open science schools of thought.
Source: Fecher and Friesike (2014)

consuming peer review of research articles (Priem and Costello 2010); impact is measured with respect to a journal rather than directly to an article (McVeigh, 2004); impact factors cannot be assigned to new publication methods like blogs and open access (Priem et al. 2010; Yeong and Abdullah 2012). Open science therefore supports the inevitability of using altmetrics such as number of views, comments, tags, blogs and tweets in measuring the impact of scientific articles and the contributions of their authors to scientific research.

The academic library, research and open science

Libraries and their parent institutions are in the forefront in the campaign for open source, open access, and open science. Libraries and researchers work hand in hand, and the researchers look to the libraries to publicize their research work, as well as giving protection to their work through copyright law. Libraries are expected to create awareness of the research work of the researchers and disseminate the information contained therein; this they do through institutional repositories, which are made public both internally and externally.

The huge volume of information available for research, which has led to more metadata-related activities, offers new opportunities for librarians to communicate with new domains, including publishing, recording and content development and other allied areas concerned with digital object creation and management (Ghosh, 2009). The basic skills of librarians in locating, collecting organizing, evaluating and disseminating information have been having important effects on the creation, development and management of digital content.

Academic libraries are taking up a new role of academic publishing. According to Xia (2009), research conducted by the Association of Research Libraries (ARL) revealed that many libraries provide publishing services. The author found that there are

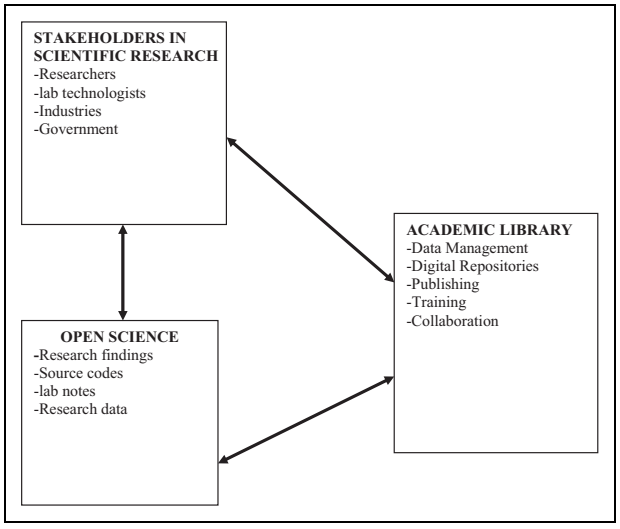

Figure 2. Conceptual framework.

371 peer-reviewed journals published by large research libraries in the USA. Smaller libraries at institutions not affiliated with ARL have also participated in publishing ventures. These libraries use a combination of publication tools such as Open Journal System (OJS) and the Berkeley Electronic Press. Library publishing discussions have focused on the applicability, sustainability, and scalability of providing such services. According to Bankier and Perciali (2008), academic libraries became alternative publishers by uploading the research output of their local community into their institutional repositories.

Jaguszewski and Williams (2013) and Corrall (2014) show that scholars have a positive attitude towards cooperating with librarians and are willing to take the responsibility of organizing an editorial process for the quality control of publications. Increasingly, there are buy-ins from those who have served as editors of journals published by traditional publishers. From the faculty editors' point of view, the new model of scholarly communication is able to provide many more benefits than the traditional model of publishing: free access for readers (through libraries' websites), inexpensive hosting (even though libraries have to pay the costs), and convenient management (through collaboration with other libraries. This could be achieved through building institutional data repositories by librarians with contribution from scientific researchers in the faculties.

According to Giarlo (2005), researchers are looking to libraries to promote open science/open access. The propagation and/or advocacy of open access are not claimed by any constituency as belonging to their domain. Libraries need to take the lead and assume that open access is their obligation because its focus is on making information available to those that need it to change their lives or add to their knowledge and innovations. If librarians accept open access as their domain, they must also engage in activities that will encourage researchers to continue to grow and develop open access. Martell (2008) reminded us that the access paradigm has supplanted the ownership paradigm since the late 1970s and held sway through the remaining years of the 20th century. However, the availability of serials electronically has increased to such a degree that while ownership, as traditionally conceived, is no longer practical, immediate access is practicable. Recently, the exponential growth of institutional repositories and open access publishing models has swung wide open the access paradigm. For the vast majority of the population familiarization with new gadgets and new methods of locating information requires guides, and librarians can easily fit into this role with training. It follows that academic libraries should be places of training in the new ways of relating with research, especially scientific research, as it is in the makerspaces of some university libraries.

Academic libraries today play more roles in the management of research data. While science data services in libraries have existed for decades, the advent of digital data has brought major enhancements to the access and manipulability of data. Today, libraries' roles in data management and data services tend to relate to a few well-defined categories of data: social science data, geo-referenced data (GIS), and bioinformatics data. (Kinikin and Hench, 2005). While librarians with domain expertise may be prepared to partner with researchers and faculty members, library relationships with laboratory and research centre data managers also deserve further attention and exploration. Even when they do not offer a full-service data program or hire dedicated staff with data expertise, libraries provide significant data services across many fields. Many libraries in the USA, for example, acquire data sets through the US federal depository program, or through traditional acquisitions and licensing sources (Gold, 2007). Indeed, reference data available in the form of printed handbooks can now be found on the web or as part of commercially produced digital products. Enhanced searching and linking within these sources increase their value to library users.

Institutional repositories are today important for academic institutions; the libraries of these

institutions are usually the custodians of these repositories. Chang (2003) stated that librarians need to be conversant with digital collection management and open archival information system management skills. Library staff and authors need to be trained to prepare documents in acceptable formats and to submit content to the repository using a simple interface. Academic libraries have created new library services by introducing their researchers to open access institutional repositories (IRs) for wider coverage of scholarly literature by their colleagues in the same institution (Kiran and Yip Ping, 2009). Arunachalam (2004) opined that information professionals can act as champions in their respective institutes and take the leading role in promoting the open access movement. Allard et al. (2005) identified six roles of librarians in the institutional repository environment: understanding software, project planning and management, collection definition, metadata guidance, submission review, and author training. Bailey (2005) suggested possible activities for reference librarians in institutional repositories which include helping to create sensible institutional repository policies and acting as change agents by promoting the repository to faculty and graduate students in their subject areas.

There are numerous benefits of institutional repositories, from making the institutions more visible, helping to market institutions both internal and externally, making it possible for the university to employ more qualified staff, helping the institution to attract foreign grants and enhancing students' academic performance (Grundmann, 2009).

The challenges of open science

Open science undermines privacy; although it has positive effects on the scientific enterprise itself, on innovation and on society in general, there exist a number of legitimate reasons to limit the openness of science, especially around data, that go beyond technical issues and involve not only the research community but also society more generally. These include, for instance, issues related to the privacy of individuals or organisations, or national security (Czarnitzki et al, 2015). Data gathered in the course of research often contains personal information (e.g. medical records), so in opening such data the rights of data subjects must be respected (Lane et al., 2014). This does not mean that the data cannot be opened, but it does call for implementing protective procedures. One such procedure is anonymization, which may, however, lead to the inapplicability of the whole personal data protection regime.

Research data, and data in general, are in most cases intangible assets involving different authors and stakeholders alongside the different phases of data creation, compilation and reuse. In this respect, several authors can claim ownership of the same data sets. Research data can be created or collected by an individual, then used by another party, and subsequently the information can be compiled and edited by others (Pampel and Dallmeier-Tiessen, 2014). A third party funding or commissioning some or all of the activities above can claim ownership of the data. In some fields of science, many of these tasks can be performed by machines or automated action.

Brase (2009) is of the opinion that in many scientific communities there is as yet no standard data quality assessment protocol as exists for scientific publications. He further asserts that data have little value if they do not meet minimum quality criteria. For him 'good quality data' implies data that is not only accessible (for example, available on the Internet), but also intelligible, assessable, trustworthy and reusable. In this respect the development of detailed data-sharing information and metadata is essential for the further use of the same data from multiple teams of researchers. Unfortunately, scientists and researchers do not necessarily have the incentives or the skills to perform these tasks, since proper curation and dissemination of data sets is costly and time-consuming and can even be considered as another type of scientific output (Uhlir, 2012).

A possible solution to disincentives is data citation: the possibility for researchers to be acknowledged for their work of data collection and curation through mechanisms similar to that already in place for citations of academic articles; on the other hand, some scientists disagree with data citation as a standard measure for quality data. Data citation, however, is not necessarily a standardised or widely accepted concept in the academic community. Some scientists see it as being limited to citation to scientific articles; some funding agencies question the idea of recognising individuals as data authors; and traditional bibliometric indicators are not yet taking non-article citations into account (Costas, Zahedi and Wouters, 2015). In addition, there are technical barriers restricting the development of data citation and related metrics: these include incompatibility in machines and software, data file structures, data storage and

management (Groves et al., 2010). A number of organisations are actively engaged in overcoming these challenges.

According to Jankowski et al.(2012), data citation has some unique features, owing to the particular properties of data sets. For instance, data sets may be of very different sizes and it is not always clear to which specific elements inside the data sets scholars are referring – or in the case of updates to the data sets, which version to cite. Wigboldus and Dotsch (2015, p.4) argued that " . . . in science, there is no such thing as a questionable research practice when it concerns data analyses" as long as researchers share the details of all analyses conducted. They opined that the label "questionable research practices" will likely discourage researchers from data exploration that may help reduce false-positive rates but will also very likely increase false-negative rates by virtue of limiting the opportunity for new discoveries. Knowledge of this valid argument will go a long way in encouraging researchers to embrace open science.

Conceptual framework

The conceptual framework shows the relationship between the major variables of the study, academic library and open science, and the major constructs associated with each variable. It must, however, be noted that Open Science cannot be isolated from the science researcher. The scope of this study does not cover all the stakeholders in science; discussions on open science will often be with reference to the science researcher.

Conclusion

Open science is the way to go in today's world of technology driven processes, and scientific research processes are not left out of the changes that are taking place. New sophisticated equipment in laboratories driven by computerised systems, large volumes of data, open access to source codes and new ways of assessment of scientific publications (altmetrics) are some of these changes. The major stakeholders, scientists, therefore cannot be resistant to these changes.

Academic librarians play a pivotal role in locating, evaluating, collecting organizing and disseminating information. Ghosh (2009) affirms that the huge volume of information available for research has led to more metadata-related activities that offer new opportunities for librarians to communicate with new domains including publishing, recording and content development and other allied areas concerned with digital object creation and management. Librarians play a leading role in the creation, development and management of digital content, making information accessible to the public. Since open science allows open access to someone else's information, it raises issues of legal and privacy, which may put academic libraries to task. For example, while some people would not want to make their health records made public, legal and privacy implications are not always considered along with open access. The proponents of open science are still grappling with how they can address the anonymity problem. This is where the attribute of academic libraries as good custodians and managers of information comes into play.

Academic libraries need to be involved more in advocacy, to encourage scientists and other stakeholders in the scientific research process who are skeptical about open science to join the movement. Many academic libraries are focusing all their attention on building and maintaining institutional repositories that basically consist of journal articles and monographs, but there is a need for them to also give consideration to data repositories. This will further encourage scientific researchers, give them the confidence to embrace open science and help young researchers to have access to secondary data.

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