Abstract
This paper describes data literacy and emphasizes its importance of data literacy. Data literacy is vital for researchers, who need to become data literate science workers and also for (potential) data management professionals. Its important characteristic is a close connection and similarity to information literacy. To support this argument, a review of literature was done on the importance of data, and the data-intensive paradigm of scientific research, researchers' expected and real behaviour, the nature of research data management, the possible roles of the academic library, data quality and data citation, Besides describing the nature of data literacy and enumerating the related skills, the application of phenomenographic approaches to data literacy and its relationship to the digital humanities have been identified as subjects for further investigations.

Keywords
Data literacy, research data management, data curation, data sharing, data quality, data citation, data librarian

Introduction

Every other year the Association of College and Research Libraries (ACRL) Research Planning and Review Committee identifies the top trends in academic libraries. The 2014 list of these trends points towards data-related issues, underlining that the increasing importance of open data, data-plan management, and big data give impetus to develop and deploy new initiatives, service units, and resources to meet scholarly needs at various stages of the research process (ACRL, 2014). These trends and issues are predicted to affect all libraries and librarians, especially academic and research libraries. The awareness of these needs and the involvement of different stakeholders (research funders, data managers, research institutions and publishers) are fairly different by regions and by countries.

This paper, has a number of objectives: to paint a picture about the importance of data, to give insight into the related behaviour of the research community and reveal both the motivation to engage in research data management (RDM) and the barriers of open data. In order to understand the role of academic and research libraries in data management in a wide sense, different issues of data quality and problems of data citation will be examined and supplemented by a summary of approaches to data literacy. The main goal of this writing is to provide a proper definition of data literacy, to identify some of the related skills and to offer topics for further investigation.

Literature review

This review of the literature is divided into several sections that examine the most pertinent issues that have been selected from a wide array of data-related subjects. The first section examines the importance of data, focusing on the data-intensive paradigm of scientific research. The next section outlines how researchers are expected to behave and how they behave in reality. The nature of research data management (RDM) is examined in the third section, while the fourth one addresses the possible roles that the academic library can play in RDM. Separate sections are dedicated to the issues of data quality and data citation. The literature review is completed by considerations about how to approach data literacy.
In this paper, the concept of the 'academic library' will be taken in a broad sense, as it also includes *research libraries*, i.e. "libraries that support research in any context: academia, business and industry or government" (Maceviciute, 2014: 283).

The importance of data

Data is a starting to perform new currency for connecting people and ideas, thus taking over some of the tasks media traditionally has taken (Smith, 2013). This and other statements clearly show how much interest data raises. Data-intensive science is clearly emerging (Hey and Hey, 2006; Lynch 2009).
Data can be defined as "any information that can be stored in digital form, including text, numbers, images, video or movies, audio, software, algorithms, equations, animations, models, simulations, etc." (National Science Board, 2005: p.9).
Data comes in several varieties, so it can be observational, computational, and experimental (Borgman, 2007). Research data is the output from any systematic investigation that involves a process of observation, experiment or

the testing of a hypothesis (Pryor, 2012). Data also comes from works of art and literature, as well as from artefacts of cultural heritage (Nielsen and Hjørland, 2012) and there is the big data phenomenon. Big data is not only big, but is defined by the capacity to search, aggregate, and cross-reference large data sets, and it is conditioned by the interplay of cultural, technological, and scholarly phenomena (Boyd and Crawford, 2012).
The capacity to store massive amounts of data by high bandwidth networks, supplemented by other components of today's highly developed information and communication technology (ICT) infrastructure, triggered enormous interest in research data in the natural sciences, social sciences as well as the arts and humanities (Boyd and Crawford, 2012).
The fact that researchers are less interested in raw data or in archiving it, but give attention to the use and reuse of data and its embedding context, removes some of the differences between data and information. Therefore, research data can be recognized as information (Schneider, 2013).
The spectrum of data-related activities includes data sharing, data management, data curation and data citation (Carlson, et al., 2011).
The findings of the RECODE (Policy RECommendations for Open access to research Data in Europe) project exemplify the differences in the involvement of different stakeholders in these activities. For instance, the research funders in the United Kingdom are on the forefront of policy development in Europe and we can see considerable development in Austria, Germany, Ireland and Norway. Obviously, there is considerable development in this field, also beyond the European Union, For instance in Australia, Canada and the United States open access to research data is required by a number of research funders (RECODE, 2015).

Researchers' behaviour

The success of data-intensive science depends to a substantial extent on the behaviour of researchers involved in it. Data sharing that is a central concept of data-intensive science is especially sensitive to researchers' behaviour. It is the release of research data for use by others. Several factors can motivate researchers to share their data. Sharing data may be a condition of gaining access to the data of others, and may be the prerequisite of receiving funding, as set forth by different funding agencies with a varying degree of rigour (Borgman, 2012). To be exact, even requirements by different funders to make research data available are varied by country, institution or discipline. Under these conditions, the results of an international survey of researchers' practices and perceptions regarding data sharing show that the majority of researchers

from various disciplines have a positive attitude toward data sharing, while only a minority shares their data in the real world (Tenopir et al., 2011).
As Cox, Pinfield and Smith (2014) outlined it, in the United Kingdom the need for RDM emerged in the last five years as UK research funders have become concerned with improving the management of research data and increasingly stress the value of including data.
Kruse and Thestrup (2014) report the findings of a research project that has analyzed how the Danish universities store, preserve and provide access to research data. An example of disciplinary differences is given by Vlaeminck and Wagner (2014), who describe some of the problems that lead to poor replicability of social sciences research.
Data sharing is undoubtedly a complex issue, among others by the fact that researchers have a number of reasons *not* to share their data. For instance, documenting data is extremely labour intensive. However, the main reason is lack of interest, caused by the well-known fact that in most fields of scholarship the rewards come not from data management, but from publication (Borgman, 2010). Greater openness apparently requires researchers to shift from perpetual proprietary control, to forget fears of misuse or misinterpretation. In any case, each discipline has its own 'data culture' and some data may be more uniform in their form and therefore more easily transferable than other idiosyncratic formats. Issues of security and control also play a role here. Overall, there may be a tension between funder and publisher requirements for data sharing and the technical and cultural barriers that inhibit such sharing. Notwithstanding, the scholarly community is moving inexorably toward improved access to research data and this evolution affects every part of the research process (MacMillan, 2014).
Researchers are learning data management and curation on the job and in an *ad hoc* fashion. None of them has received formal training in data management practices, despite the fact that they are not satisfied with their level of expertise. Only a few researchers think about long-term preservation of their data. This is especially true for those who are in the early stage of their career. The demands related to publishing are overwhelming and thus suppress long-term considerations of data curation. Metadata and documentation are of interest for them only if they help completing their work. Few researchers are aware of the data services that the libraries might be able to provide, especially because they seem to regard the library not as a place of real-time research support, but as a dispensary of books and articles (Jahnke, Asher and Keralis, 2012).
There are some attempts to make researchers' data management less spontaneous and more purposeful. For instance, the rules of using and caring for data, offered by Goodman (2014), can guide researchers in their effort to

ensure that their data and analyzes continue to be of value. The recommended behaviours include:

- Conducting research with a particular level of reuse in mind;
- Linking data to someone's own publications as often as possible;
- Stating if someone wants to get credit for data and describing how it may happen,
- Rewarding colleagues for sharing data;
- Publishing a description of processing steps in order to enable interpreting and reusing data;
- Fostering and using data repositories;
- Sharing data with a permanent identifier (e.g. the Digital Object Identifier, DOI).

While giving attention to enabling reuse and expressing the importance of reward for themselves and to colleagues, publishing process descriptions is comparable to including a 'methods' section into a scholarly article, which is used to describe data collection, manipulation, and analysis processes. These behaviours that can be qualified mainly as motivational can be supplemented by distinct steps that are needed for data sharing. Some of them are described by Buckland (2011) as follows:

- Discovering if the suitable data set exists;
- Identifying its location;
- Examining if the copy is usable or not;
- Clearing if it is permissible to use;
- Ascertaining its interoperability, i.e. if it is standardized enough to be usable with acceptable effort;
- Judging if its description is clear enough to indicate what the given data set represents;
- Ascertaining trust;
- Deciding if the given dataset is usable for someone's purpose.

Research data management

The attitudes and behaviours of the researcher, described above are the foundation of managing data by themselves and by other actors involved in its processes and services. The latter, often called 'research data services' (RDS) is required by the data-intensive paradigm of research and it can be integrated into library services (Tenopir et al., 2014). RDS may consist of *data management* and *data curation*, which are not identical, but do not seem to be clearly separated from each other. Management in this environment is usually

research data management, which is often viewed in very different ways by different groups of professionals.

RDM and RDS may be considered arenas, where various professions meet and vie for jurisdiction over a newly emerged area of work. A study by Verbaan and Cox (2014) showed that the library was the only organization, which claimed a new jurisdiction in these fields. This could be seen as an extension of its existing jurisdiction in open access and information literacy.

Data curation aims to make selected data accessible, usable, and useful throughout its lifecycle. It subsumes digital preservation and provides context by supplying documentation, descriptive metadata, or both (Giarlo, 2013).

The data curation poses, raises questions, related to ownership of the data, its retention, maintenance, access to it, its openness and costs. In this context, the following questions have to be answered by data curators.

- Who owns the data?
- What requirements are imposed by others (such as funding agencies or publishers)?
- Which data should be retained?
- For how long should data be maintained?
- How should it be preserved?
- What are the ethical considerations, related to it?
- What sort of risk management is needed?
- How is data accessed?
- How open should it be?
- How should the costs be borne?
- What alternatives to local data management exist? (Erway, 2013).

Data curators can be involved in a number of activities. They can:

- Elaborate digital curation policies, procedures and practices;
- Plan, implement and monitor digital curation projects and services;
- Select digital documents for long-term preservation;
- Communicate the value of digital curation to existing and potential stakeholders;
- Diagnose and resolve problems to ensure continuous accessibility of digital objects;
- Monitor the obsolescence of file formats, hardware and software and the development of new ones;
- Identify methods and tools that enable interoperability of different applications and preservation technologies;
- Verify and document the provenance of the data to be preserved;

- Establish and maintain collaborative relationships with various stakeholders;
- Organize and manage the use of metadata standards, access controls and authentication procedures.
- Organize personnel education, training and other support for adoption of new developments in digital curation;

Closely related to these potential duties, they should be familiar with the following issues:

- The data structure of different digital objects;
- The ways to assess the digital objects' authenticity, integrity and accuracy over time;
- Storage and preservation policies, procedures and practices;
- Relevant quality assurance standards;
- The risks of information loss or corruption of digital entities;
- Requirements to information infrastructure in order to ensure proper access, storage and data recovery (Madrid, 2013).

The role of academic and research libraries

In the same way as the library has traditionally facilitated access to documents, today information professionals could facilitate access to data, even though data do not necessarily fit into the same, document formats that libraries used to offer (Stuart, 2011).

The *tsunami of data* (Bradford and Wurman, 1996), or *data deluge* (Borgman, 2012) lays a charge on libraries, in particular academic and research libraries. This possible involvement of libraries in data-related activities has been indentified early. For instance, Perry, Roderer and Assar (2005) noted that the boundaries between published literature and research data are disappearing, which gives opportunities for both librarians to create, maintain, and develop integrated information resources.

Tenopir, Birch and Allard (2012) emphasized that libraries have an opportunity to create a new profile on campus as a partner in knowledge creation because there is a convergence between data-intensive science, technological advances and the expertise of librarians, which can make them more visible in the knowledge creation process. Accordingly, librarians should be placed at all stages in the research planning process and provide expertise in developing data management plans, identifying appropriate data description and creating preservation strategies.

The Association of Research Libraries (ARL) declared that academic libraries are in a favourable position to help researchers to meet the challenges of a data-intensive research paradigm because they are increasingly providing data consultation services and have experience and skills in fostering cross-departmental, cross-campus, etc. communication and collaboration, needed for effective research data management. It is underlined that librarians are familiar with the research data needs of researchers and have been among the supporters of innovative publishing models, including open access publishing. They are already involved in acquiring necessary abilities to manage data (Hswe and Holt, 2012).

The growing importance of research data management has been identified as an increasingly important trend not only in the already mentioned report of the ACRL Research Planning and Review Committee (ACRL, 2014), but also in the Horizon Report of the New Media Consortium (NMC, 2014). More recently, Marcum (2015) pointed out that there is a need for attention to data curation in research library settings. She also underlined that professionals, who can assist scholars with their research are highly requested. It can be said that scientific data curation service has become a new embedded information service (Li et al., 2013).

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There are contradictory opinions about the readiness of libraries for data management roles. While Pryor (2012) stated that there is growing acceptance that they play a major role, the RECODE (2015) project found that there is an apparent lack of current practices, especially in digital preservation strategies, as well as in terms of meeting the demands of researchers and users in the provision of data management and support services. On the other hand, Soehner, Steeves and Ward (2010) expressed the opinion that the expertise of librarians in collection development, information organization, resource discovery, repository management and digital preservation is extremely useful. It provides namely the foundation for being able to help researchers in the creation of better outputs in the form of more useful data, thus libraries can participate in the phase of research that precedes publication (Federer, 2013). Besides of this, libraries have been historically attached to providing quality

information. This predestines them to the critical role of being data quality hubs, by providing data quality auditing and verification services for the research communities (Giarlo, 2013).
Seadle (2012) identified a different point of argument. Libraries collect and preserve textual material. This fact did not mean in the past that librarians would have been involved in teaching people to read. However, data is different, because reading data requires skills that librarians may need to teach to users in order to help them seek and acquire meaning from it.
As late as 2014, we repeatedly find the argument that the use of data resources is a key area, where libraries and librarians can take a leadership role. In fulfilling this role, the inclusion of data literacy is said to be essential (MacMillan, 2014).
In 2012, a working group of the Association of European Research Libraries (LIBER) declared that libraries should assist faculty with the integration of data management into the curriculum. To enable this, ten recommendations on research data management have been published, which underline, among others, the importance of re-skilling librarians. Re-skilling is utterly important not only because information professionals have to be prepared for new roles to support the complex scientific systems, but also for practical reasons, first of all because very few libraries are able to hire new, specialized staff, which would be. Consequently, the role of a data librarian and other data professionals can be fulfilled by reskilled information professionals, even though being a data librarian may be a profession in itself (Ramírez, 2011; Christensen-Dalsgaard et al., 2012).
As to competencies, there may be a need for technological competencies that range from database design and content management, as well as data mining and programming. Even tough the level of required domain expertise and technical know-how needs further investigation, there is agreement that a breadth of skill sets is needed, including personal, interpersonal, and managerial abilities (Cox and Corrall, 2013).
The fields of involvement of academic and research libraries in providing research data services cover the full data lifecycle, including planning, curation, and metadata creation and conversion (Tenopir et al., 2013). Mapping potential roles of the library to a research lifecycle model show that this is a valid argument. The roles (at several points identifying potential partner services) are the following ones:

- Gathering requirements for research data management (with academic departments);
- Planning RDM, including advocacy and guidance to researchers (with doctoral training centres);

- Technical advice on data formats and metadata;
- Data citation;
- RDM training (with doctoral training centres);
- Licensing research data;
- Appraising research data;
- Storing research data (with IT services);
- Access research data;
- Assessing the impact of research data (with research support offices) (Lyon, 2012).

Activities go beyond RDM in the strict sense. The findings of a survey, offered by Tenopir, Birch and Allard (2012) show that research data services, currently offered or planned to be offered in the future by academic libraries in the United States and Canada address the full data life cycle. This means that RDS consist of informational services, like consulting with faculty, staff, or students on data management plans and metadata standards; providing reference support for finding and citing data sets; or providing web guides and finding aids for data or data sets. They include as well as technical services in the form of providing technical support for data repositories, preparing data sets for a repository and deselecting them from a repositories, or creating metadata for data sets. Corrall et al. (2013) found that in Australia, Ireland, New Zealand and the UK, libraries offer help in finding external datasets.

The ways in which we can label the roles that information specialists are involved in data-related issues, are still evolving. Among the possible names, Loukides (2012) found *data consultant*, *data librarian*, *data manager*, *data management consultant*, *data curator, data officer, data scientist and research informationist*. However, we have to be aware that not all of them may be open for librarians and there are opportunities not only for librarians, but they exist for institutional repository managers, and data curation specialists, as well (Carlson et al, 2011).

The origins of *data librarianship* and the title *data librarian* go back social science data (particularly publicly available data sets and geospatial data), then evolved to the bioinformatics field. The concept and the title now cover library-related work with both purchased and locally produced digital data in any subject domain (Soehner, Steeves and Ward, 2010).

Another label, put to these functions is *scholarly communications librarian*, whose duties are closely tied to information literacy (Davis-Kahl, Fishel and Hensley, 2014). An analysis of job advertisements for such posts by Bonn (2014) shows that, besides calling for master's degree in library and information science and advanced disciplinary degrees and the obligatory excellence in oral

and written communication, the requirements include an understanding of best practices in data management and curation.
Reilly (2014) explained that libraries will be able to provide data management only in if they cooperate with researchers. Collaborations have come about with relevant institutional departments, IT services and institutional and national data centres.
Besides the need for increasing focus on research data management, the NMC Horizon Report (NMC, 2014) identified the necessity in supporting new evolving forms of multidisciplinary research. This is forecasted as a long-range trend, which academic and research libraries will have to adopt. While contemporary workforce is inherently multidisciplinary in that a diverse range of skills is needed for a person to be successful in their position, digital humanities and computational social science research approaches fulfil pioneering role here.
At present, amongst library and information professionals, there seems to be a significant amount of enthusiasm about research data management. This feeling itself may become a driver for change by encouraging librarians to implement change in line with current trends in the profession. However, at some point, this positive perception will turn negative as the scale and complexity of the challenge, its implications and constraints become more apparent. While this is likely to happen, it is also probable that the current powerful drivers for RDM will remain (Cox and Pinfield, 2013). The same is expected concerning data literacy.

Issues of data quality

If libraries' aim is to become quality hubs, as said above, it is paramount to know, how data-intensive research can produce data of satisfactory quality. This is the reason, why appropriate attention has to be given to data quality.
The difficulty is in appraisal of data, which requires deep disciplinary knowledge. In addition to this, manually appraising data sets is very time consuming and expensive, and automated approaches are in their infancy (Ramírez, 2011). Notwithstanding, data quality is one of the cornerstones of the data-intensive paradigm of scientific research that is determined by multiple factors. The first one is trust, which is complex in itself. The elements of trust include the lineage, version and error rate of data and the fact that they are understood and acceptable (Buckland, 2011).
By reviewing quality attributes extensively, Giarlo (2013) argues that trust depends on subjective judgements on authenticity, acceptability or applicability of the data; and is also influenced by the given subject discipline, the reputation of those responsible for the creation of the data, and the biases of the persons

who are evaluating the data. It is also related to cognitive authority, which has two levels. At an operational level, cognitive authority is the extent to which users think that they can trust the information. On a more general level, cognitive authority refers to influences that a user would recognize as proper because the information therein is thought to be credible and worthy of belief (Rieh, 2002).
The next factor of data quality is authenticity, which measures the extent to which the data is judged to represent the proper ways of conducting scientific research, including the reliability of the instruments used to gather the data, the soundness of underlying theoretical frameworks, the completeness, accuracy, and validity of the data. In order to evaluate authenticity, the data must be understandable.
The presence of sufficient context in the form of documentation and metadata allows the evaluation if data is understandable. To achieve this, data has to be usable. To make data usable, it has to be discoverable and accessible; and be in a usable file format. The individuals judging data quality need to have at their disposal an appropriate tool to access the data, which has to show sufficient integrity to be rendered. Integrity of data assumes that the data can be proven to be identical, at the bit level, to some previously accepted or verified state. Data integrity is required for usability, understandability, authenticity, and thus overall quality (Giarlo, 2013).

The problems of data citation

As data citation is in close association with data sharing, there is a need for the recognition of data as a significant contribution to the scholarly record.
Standardized forms of data citation would be of utmost importance as they are a potential source of motivation for researchers to share and publish their data, with the possibility of becoming a source of reward and acknowledgment for them. Information professionals could operate in close collaboration with researchers in advancing reward and acknowledgment by promoting the use of data citation standards.
While in 2012 Mooney and Newton (2012) asserted that full citation of data is not yet a normative behaviour in scholarly writing, when reviewing the evolution of data citation standards and practices, Altman and Crosas (2013) stated that data citation is rapidly emerging as a key practice. The perceived lack of community cohesion around the best practices for data citation, which would allow the identification, retrieval, replication, and verification of data underlying published studies, is rapidly being amended through different initiatives, such as

DataCite[1] or the DataVerse Network[2] (Mooney and Newton, 2012). There is also a document on data citation standards and practices, devised by the Committee on Data Science and Technology of the International Council for Science (CODATA 2010), the data citation guides of the International Association for Social Science Information Services and Technology (IASSIST, 2012) and the Joint Declaration of Data Citation Principles (Data Citation Synthesis Group, 2014). The principles outlined in the latter are overarching. While stressing that data citations need to be both human and machine-readable, these principles are not comprehensive, but aim to encourage communities to develop practices and tools that embody these principles (RECODE, 2014). Thomson Reuters, a major commercial information provider also sees the importance of data citation. Their Data Citation Index appears to be heavily oriented towards the natural sciences (Torres-Salinas, Martín-Martín and Fuente-Gutiérrez, 2014). Taking into consideration that style guides and normative practices do not universally embrace data citation, while there is a relative proliferation of various data citation suggestions, the goal of the IASSIST Quick Guide was identify the essential elements and provide practical examples in common referencing styles (Mooney, 2013).
From the review paper by MacMillan (2014), it becomes clear that data citation mechanisms based on persistent identifiers like Digital Object Identifiers (DOIs) may facilitate data discovery and interoperability with the scholarly literature
Peroni et al. (2015) describe the possible outlook and advantages of the Open Citation Corpus (OCC), which is a new open repository of scholarly citation data. OCC is encoded as Linked Data, i.e. data structured in a way that it can be interlinked and become more useful through associative and contextual queries and is made available under a Creative Commons licence.

Approaches to data literacy

As it is can be supposed and as the example of information literacy suggests, there are a number of different approaches to data literacy.
Already in 2004, Schield stated that data literacy is dependent on critical thinking. He compared it to information literacy, which presupposes the ability to think critically about concepts, claims and arguments, while being data literate we must be able to access, assess, manipulate, summarize and present data (Schield, 2004).

[1] http://www.datacite.org/
[2] http://thedata.org/

According to Qin and D'Ignazio (2010), data literacy – though named by them *science data literacy* – is the ability of understanding, using and managing (science) data.

Data literacy can be simply defined as "the ability to understand and use data effectively to inform decisions" (Mandinach and Gummer (2013, p.30). On the other hand, this definition indicates that data literacy is a specific skill set and knowledge base that enables us to transform data into information and ultimately into actionable knowledge, which comprises developing hypotheses, identifying problems, interpreting the data, and determining, planning, implementing, as well as monitoring courses of action.

According to Calzada Prado and Marzal (2013), data literacy enables individuals to access, interpret, critically assess, manage, handle and ethically use data. Managing, that appears in this definition comprises preservation and curation, and this definition is much more comprehensive than the above ones.

Data literacy, as it is understood by the Association of College and Research Libraries, focuses on understanding how to find and evaluate data, giving emphasis to the version of the given dataset, the person responsible for it, and does not neglect the questions of citing and ethical use of data (ACRL, 2013).

Johnson (2012) defined data literacy as the ability to process, sort, and filter vast quantities of information, which requires knowing how to search, how to filter and process, to produce and synthesize. It is clear that these are also the characteristics of information literacy as they appear in the well-known and widely accepted definition of information literacy, which comprises the abilities to recognize information need, identify, locate, evaluate, and use information to solve a particular problem (ALA, 1989). The newly developed *Framework for Information Literacy for Higher Education* sets different accents on information literacy that will need a thorough examination in the future. At the moment, the following statement from the Framework can be underlined: "Recognize that information may be perceived differently based on the format in which it is packaged" (ACRL, 2015). This sentence can be interpreted as the implied recognition of the fact that information literacy is pertinent to data, as well.

When recommending unified terminology and voting for the use of the term *data literacy*, Koltay (2015) identified several differing concepts and terms that are used for denoting this concept. There is *data information literacy* (Carlson et al., 2011), *science data literacy* (Qin and D'Ignazio, 2010) and *research data literacy* (Schneider, 2013).

Beyond definitions, we find required skills and abilities. Carlson et al. (2011) name both general and specific skills. The first group contains drawing correct conclusions from data, and recognizing when data is being used in misleading

or inappropriate ways. In the second group we see the ability of reading graphs and charts appropriately.
Later publications seem to focus on general skills that are also foundational to information literacy. According to Calzada Prado and Marzal (2013), data literate persons have to know how to select and synthesize data and combine it with other information sources and prior knowledge. They have to recognize source data value, be familiar with data types and formats.
Mandinach and Gummer (2013), enumerate data literacy skills that include knowing how to identify, collect, organize, analyze, summarize, and prioritize data. The last two skills are especially worth of attention as they are the ones that do not appear in other lists. Developing hypotheses, identifying problems, interpreting the data, and determining, planning, implementing, as well as monitoring courses of action also pertain to required skills and add the need for tailoring data literacy to the specific uses.
The Association of College and Research Libraries (2013) focuses on understanding how to find and evaluate data, giving emphasis to the version of the given dataset, the person responsible for it, and does not neglect the questions of citing and ethical use of data. This literacy concentrates on ownership and rights issues, and cuts across disciplinary boundaries and the traditional structures of academic library organizations.

Data literacy for researchers and librarians

The main goal of involving libraries and librarians into the processes of data-intensive research is to provide help that makes it more efficient. Data literacy's goal is not different as it intends ultimately enable adequate research data management in a wide sense. Providing data literacy education is a service that also appears in the predictions about future directions for academic libraries (Merrill, 2011). Its importance is also underlined by expanding the view on what we mean by data (ACRL, 2013), and it receives accent as employers require data librarians that they fulfil the role of data literacy educators (Si et al., 2013).
Data literacy is conceived predominantly for those who will use the data and will need education about how to understand and interpret it (ACRL, 2013). Acquiring data literacy skills is thus an issue for researchers, including graduate and doctoral students, who need to become data literate science workers. As Haendel et al. (2012) states, creating a culture of semantic researchers, i.e., enabling researchers to approach research data in an adequate and efficient way requires that we accompany their scientific training with education in data literacy.

As MacMillan (2014) asserts in his review article, instruction in the use of data resources is relevant both at the undergraduate and graduate levels. In accordance with this, Shorish (2015) argues that data literacy skills are relevant even if students do not continue their studies to attain more advanced degrees. Indeed, as early as 2004, Hunt (2004) presented a case study from the University of Winnipeg, where a data literacy course has been devised to be integrated into the subject curriculum of human geography. In 2007, Stephenson and Schifter Caravello (2007) described an experimental data literacy course taught for undergraduates at the University of California Los Angeles that reflected on sociological research problems and tools.

The library is indicated in the RECODE recommendations as the primary locus for training and awareness-raising for researchers (RECODE, 2015). Libraries also could extend their role in supporting public engagement with science, among others by acting as hubs for citizen science (Lyon, 2012).

Wong (2010) described an information literacy course that centred on socioeconomic data, offered at the Library at the Hong Kong University of Science and Technology with the teaching objectives of helping students to understand the nature of socioeconomic data by comparing it with other scientific data, with which they are more familiar, as well as guiding them in data-collection, evaluation and dissemination. More recently, McMillan (2015) described the development of two data literacy workshops, designed to scaffold student learning in the biological sciences across two second-year courses, detailing the long-term collaboration between a librarian and an instructor. An evaluation of a data literacy education programme to graduate students at the College of Agriculture at Purdue University by Carlson and Stowell Bracke (2015), demonstrates that the demand for data literacy programs will increase, as data management and curation become a more normative part of scholarship.

Data literacy is also vital for (potential) data librarians, who intend to acquire skills and abilities that are required for fulfilling their role as effective and efficient supporters of researchers. Even if this duality of target audiences exists, it is difficult and often unnecessary to separate the data literacy skills of the researcher and of the librarian from each other.

Definition and scope

To appraise the importance of data literacy and see a full picture of its educational role, mentioned above, we have to provide a comprehensive definition of data literacy. Following the line of thought of Calzada Prado and Marzal (2013) and of Mandinach and Gummer (2013), we can identify data

literacy as a specific skill set and knowledge base, which empowers individuals to transform data into information and into actionable knowledge by enabling them to access, interpret, critically assess, manage, and ethically use data.

Not forgetting that literacies are multiple, multimodal, and multifaceted (Coiro et al., 2008), it seems to be of secondary importance if we treat data literacy as a component of information literacy, or as a literacy on its own. Declaring its 'independence' would not change its conceptional base. On the other hand, regarding it as a part of information literacy would not fundamentally change its functionality. Much more important is to emphasize that expanding the scope of information literacy to include data management and curation is a logical development (Carlson et al., 2013). This idea is not without antecedents, as it was supported in the UK by the Society of College, National and University Libraries' (SCONUL) Seven Pillars information literacy model (SCONUL, 2011), and Vitae's Researcher Development Framework that is intended to describe characteristics of anyone conducting research in UK higher education (Vitae, 2011). It is also underlined in the Australian and New Zealand Information Literacy Framework that information literate persons obtain, store and disseminate not only text, but data, as well (Bundy, 2004).

When speaking about the problem of different terminologies, it is necessary to declare that voting for the term *data literacy* is motivated first of all by the fact that this term is simple and straightforward. Notwithstanding, adhering to it does not exclude that we recognize its close relationship with information literacy, which already characterized some of the writings reviewed above.

When speaking about the issue of finding the proper name for the phenomenon that we named *data literacy*, it seems to be helpful to look at the difficulties experienced in the naming practices of information literacy. As Hunt (2004) explained, there may be no agreement on the precise definition of information literacy. Nonetheless, most people use the term *information literacy* rather than *library instruction* or *information fluency*. However, if we do not use the same language, it will be difficult to convince our stakeholders about the importance of information literacy education. In the case of data literacy, we may experience the same.

Determining when data is needed, deciding on their pertinence to someone's information needs, critical assessment and application to problem solving, listed by Calzada Prado and Marzal (2013), are basically identical with the best known skills of information literacy, set forth by the definition of information literacy by the American Library Association (ALA, 1989), already mentioned.

This concurrence is partially a consequence of the blurring boundaries between *information* in information literacy and data literacy. In fact, theses boundaries never have been rigid, as information literacy has always been interested in the

proper understanding and use of data that is converted into information (Schneider, 2013).

Discovery and acquisition of data occupy a prominent place. In particular, locating and utilizing disciplinary data repositories has to be emphasized here (Carlson et al., 2011). Discovery includes the knowledge on how to select data and needs to be supplemented by the ability to synthesize data and combine it with other information sources and prior knowledge. All these abilities need to be based on the skills of identifying the context where data is produced and reused (Calzada Prado and Marzal, 2013).

The need for critical assessment also occupies a distinguished place among the general features of data literacy, as well as of information literacy. Being critical includes giving emphasis to the version of the given dataset, the person responsible for it (ACRL, 2013).

Data quality is vital for data literacy (Calzada Prado and Marzal, 2013). It comprises tracking back data provenance (Buckland, 2011), and includes tracing all contexts and transformations, which the data has gone through and it is the key to verifying the authenticity and reliability of data files (Ramírez, 2011). As the review of literature has also demonstrated, data curation and data citation are crucial, as well (Carlson, et al., 2011).

The skills, enumerated above apply both to researchers and to librarians. The differences seem to be much more in disciplinary variations that would incorporate technologies or techniques specific to the given discipline. Still, skills or at least emphasis on them may be differing, according to particular roles.

In the case of the use of metadata may be regarded as an exclusive task for the librarian, while some of the requirements set by Carlson et al (2011), like understanding the rationale for metadata or reading and interpreting metadata from external disciplinary sources is advantageous also to the researcher. In the bottom line, metadata is a key element in quality assurance.

Data literacy should motivate researchers to openness, i.e. sharing data with others. The problem is not only the lack of motivation, but the shortage of incentives that would rely less on ‘stick’ of funder and publisher requirements and more on the ‘carrots’ in institutional and discipline reward systems levels (MacMillan, 2014).

It is important not to forget that there is no single literacy, which would be appropriate for all people or for one person over all their lifetime without constantly updating concepts and competences in accordance with the changing circumstances of the information environment (Bawden, 2008). In other words, it is unlikely that one particular model of literacy could be appropriate for all members of a society across all contexts (Livingstone et al.,

2014). This is also a fact to be taken into account when thinking about data literacy.

Further investigation

In the case of an emerging practice, it is indispensable to explore, which direction it may go in the near future. This is the reason, why two of the possible directions are descried below.
The seven faces of information literacy, advanced by Bruce (1997) are an example of the phenomenographic approach, explained by Yates, Partridge and Bruce (2012). This approach is basically directed at studying variation in people's ways of experiencing different phenomena and can be useful in the study of information literacy (Limberg, Sundin and Talja, 2012). If we take the closeness of relationships between information literacy and data literacy into consideration, it is feasible to presume that phenomenographic approaches deserve further exploration, through the lens of data-intensive research and data literacy.
The achievements of the digital humanities represent another significant issue, which already had significant influence in scholarly communication (Sula, 2013). Even more, Vandergrift (2012) simply declared that libraries and digital humanities have the same goals. Notwithstanding, the perhaps most characteristic feature of the digital humanities is that it "explores a universe in which print is no longer the exclusive or the normative medium in which knowledge is produced and/or disseminated" (Schnapp and Presner, 2009). These features show that the relationship between the digital humanities and data literacy seems to be promising subject of further investigation.

Conclusion

After a review of the literature that covered the importance of data, the related behaviour of the researcher, the nature of research data management, the possible roles that the academic library can play in research data management, data quality, data citation and approaches to data literacy, a comprehensive definition was provided that emphasized the importance of accessing, interpreting, critically assessing, managing, handling and ethically using data. This definition underlines the close relationship between data literacy and information literacy. It was also stressed that both researchers and data management professionals have to become data literate, even though differently. Skills sets of data literacy have also been identified, giving especial attention to the complexity of data quality. As subjects of further investigation,

phenomenographic approaches and the relationship to the digital humanities were indicated

While data literacy opens new horizons, some precaution is needed. As Bosanquet (2010) described it, librarians followed various, particularly technological, trends without critically examining their potential advantages and disadvantages in an effort to show innovation. In many cases, they did this without clearly indicating the outcomes. This reminds us that such pitfalls should be avoided in the case of data literacy.

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