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Alfabetización de datos para la ciudadanía: Formulación de algunas recomendaciones políticas a través de una revisión de la literatura

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Abstract

There has been a massive increase in digitalization and datafication within societies over the last years. In this context, the concept of data literacy has also gained in importance, as it is seen as one of the skills that citizens require in order to navigate and participate in society. However, despite the relevance of the concept, it is yet to be discussed as to the ways to promote it at the institutional level. In order to perform such a task, we conducted a review that combines approaches from a mapping review with that of a traditional narrative review, making a series of policy recommendations towards a data literate society. Focusing on the period between 2015 and 2021, we analysed a corpus of 39 empirical and theoretical studies. Findings confirm the scattered and interdisciplinary nature of research on data literacy, yet paving the way for a series of recommendations to promote the former.

Keywords: *data literacy, citizenry, adult education, policy recommendations, systematic review.*

Resumen

Durante los últimos años se ha producido un gran aumento de la digitalización y la datificación *de las sociedades. Por ello, el concepto de alfabetización en datos también ha ganado relevancia, y se considera además una de las principales competencias que necesitan los ciudadanos actualmente y en el futuro. A pesar de la elevada importancia de la alfabetización de datos, aún se debate sobre cómo promoverlo a nivel institucional. Para proceder con dicho debate, hemos llevado a cabo una revisión que combina los enfoques de un mapeo sistemático con los de una revisión narrativa tradicional. De este modo, se han formulado una serie de recomendaciones políticas que facilitan a nivel institucional la alfabetización en datos de la sociedad. Esta investigación se centra en el periodo comprendido entre 2015 y 2021, analizando un total de 39 estudios empíricos y teóricos. Los resultados confirman tanto amplitud como interdisciplinariedad en la naturaleza de la investigación actual sobre alfabetización en datos, lo cual allana el camino hacia la preparación de recomendaciones políticas que fomentan dicha alfabetización.*

Palabras clave: *alfabetización de datos, ciudadanía, educación de adultos, recomendaciones políticas, revisión sistemática.*

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1. INTRODUCTION

Peoples' use of digital technologies creates a considerable amount of personal information, which gives rise to a society that is data driven, often called datafied society (Lupton, 2020). Whether one sees data as a socially constructed facet of reality or reality itself, such recent hybrid encounters between technology, humans, and the data they produce warrants academic curiosity on how the latter can be interpreted, controlled, and made sense of (Lupton, 2017; 2018; Lupton et al., 2018; Pingo & Narayan, 2019). Over the last years, parallel to the increase in digitalization and datafication, the concept of data literacy has acquired importance, as it is seen as one of the required skills to understand, and participate in society. The EU General Data Protection Regulation (EU, 2016) suggests limits to organisations to protect the personal data of European citizens. Building upon this regulation, the 2018, and more recently the 2022 EU Digital Competence Framework, include information and data literacy as constituents of digital competence (EU, 2022). However, despite the growing relevance of data literacy, discussions as to the ways to promote it at the institutional level within the European context are scarce.

The aim of the study is to explore the broad field of data literacy, making literature-based policy and practice recommendations towards the promotion of data literacy at the institutional level. Within this context, the policy framework presented in this work emerged from a systematic literature review on data literacy, combining approaches from a mapping review with that of a traditional narrative review. The employed methodology considered 39 studies published between 2015-2021 that address educational and socio-political elements of data literacy. The search was carried out on four databases: Web of Science, PsycInfo, ProQuest Education Database, and Scopus.

Our results show that at state level, open access to data is key: modern local governments are encouraged to explore how to make their data open and learn about the most relevant types of data for end users. State regulation may ensure stricter enforcement of EU laws on data protection, privacy, and disinformation. Yet, public investment in education is a crucial step for a data literate population. Educational institutions ought to be equipped to teach data literacy, integrating it into the curriculum, and public libraries are advised to prepare for the provision of services related to data access. Scholars recommend a multidisciplinary approach to teaching & learning data literacy using Open Data and Open Government Data (OGD). The engagement with diverse stakeholders is also flagged as important to stimulate community participation in public affairs as much as the offer of data literacy workshops for citizens. Finally, given the complexity and importance of data as a societal actor, we illuminate further research venues.

2. METHOD

The study is part of an EU Erasmus+ project on the promotion of data literacy in adult education[1]. Diving into the research field revolving around data literacy, we conducted a review that combines the approaches of a mapping (Bond et al., 2020; Bond et al., 2021), as well as narrative review (Grant & Booth, 2009). The review process involved a group of eleven researchers: eight performed the systematic mapping, while four delved into the narrative review process (with one researcher participating in both review processes). According to Grant and Booth (2009), mapping reviews - or systematic maps – aim to depict and categorize previous research on a given topic, pointing to the need for further primary research into potentially neglected areas within the field or serving as a starting point for other forms of reviews, which is the case of the study. Thus, mapping reviews' research questions are generally broader in scope when compared to systematic reviews (Petersen et al., 2015). Being descriptive in nature, mapping reviews are characterized through a rather pragmatic approach during search, appraisal, synthesis and analysis of results. That is, the search for studies is not as comprehensive as in systematic reviews or meta-analyses, quality appraisal of identified research is not mandatorily included, findings are depicted in tabular form and analysis occurs mainly based on pre-defined key components of the included research (ibid). Narrative reviews, in contrast, employ a less systematic and transparent approach throughout these steps (Ferrari, 2015; Grant & Booth, 2009). However, in the context of this review, the narrative approach provides a means to delve into the scope of research covered in the corpus with the intention to identify the range of recommendations around data literacy covered within policy and practice contexts.

2.1 Search strategy and search string

The search string was run through four databases—Web of Science, PsycInfo, ProQuest Education Database and Scopus—in July 2021. Against the background of data literacy being a concept that is not uniformly defined, as well as navigating between sensitivity versus precision (Bedenlier et al., 2020; Brunton et al., 2012), we opted for a rather broad search string that we developed in English:

> ("Data literac*" OR "data skill*" OR "data agency" OR "data competenc*" OR "Data sovereignty" OR "algorithmic literac*" OR "algorithmic skill*" OR "algorithmic agency" OR "algorithmic competenc*" OR "algorithmic sovereignty")

2.2 Criteria for inclusion and exclusion

The initial search resulted in the identification of 1,659 contributions across the databases, which were then imported into the review management software EPPI Reviewer (Thomas et al., 2020). Within the software, 336 duplicates were removed, leaving 1 323 references to be

[1] "DaLi: Data Literacy for Citizenship" (2020-1-N001-KA204-076492); https://dalicitizens.eu. With special thanks to Svenja Bedenlier, Victoria Marín, Linda Castañeda Quintero, Inmaculada Haba Ortuño, Fryde Haram Klykken, Cecilie Hansen, Yann Mariton, Jorunn Viken, Sylvester Arnab, Daniel Villar-Onrubia, Mark Lewis, Jane Beaufoy, Gemma Tur, Barbara de Benito Crosetti, Antonio Gamundí and Lara Rodríguez Villar.

screened on title and abstract according to the pre-defined inclusion and exclusion criteria (Table 1).

Table 1

Inclusion and exclusion criteria

Inclusion	*Exclusion*
Published in or after 2015	Published before 2015
Published in the English language	Published in languages other than English
Journal articles	No journal article but book chapter, report etc.
Addressing data literacy	Not addressing data literacy
Focus on general adults as target group	Focus on children or on data-intensive professions
Primary empirical or theoretical research	Not primary empirical or theoretical research
Not sourced from MEDLINE	Sourced from MEDLINE

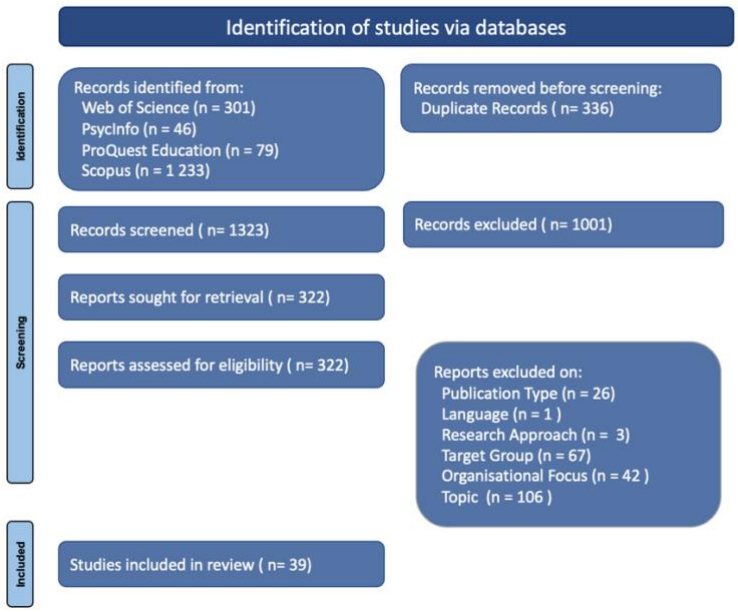
Studies published before 2015 and early childhood education were excluded from the search criteria in order to narrow down the focus of the mapping review to adult learners. The above ensuing steps yielded a corpus of 77 empirical and theoretical studies, which served as the starting point of the narrative review process (Grant and Booth, 2009). We then analysed the studies based on a pre-defined coding system, as described in the next section.

2.3 Data extraction and synthesis

In order to proceed with the review process (from mapping to narrative), we employed a coding scheme that allowed us to elicit information about approaches to data literacy regarding the meso (institutional) and macro (state) level of analysis. For the narrative review, we screened the 77 studies surveyed by the mapping review, deliberately searching for policy and practice recommendations that were not only evidence-based but also formulated as prescriptive and objective as possible. This in turn resulted in the selection of 39 studies from which the policy and practice recommendations derive, as depicted in the PRISMA flowchart (Figure 1).

Figure 2

PRISMA flowchart



Mapping and narrative reviews also bring limitations, such as the inherently descriptive and less systematic nature of both modes of review. We tackled such issues by combining both approaches, systematically reviewing the sources, coding and writing up the results.

The analysis of the coding themes (macro and meso levels) structures the presentation of the results below. The first section draws on the datafied socio-political context, followed by institutional approaches to data literacy. The latter is organized by the following five different themes emerging from the review: multidisciplinary approach, teaching & learning, external actors, data literacy workshops for citizens & libraries, and further research.

3. RESULTS AND DISCUSSION

3.1. Datafied socio-political context

We briefly explore the macro context of a datafied society with an emphasis on open data sources, continuing with possible educational courses of action to stimulate learning, community participation in, and understanding of public affairs via data literacy.

Despite the scattered nature of the field of data literacy, open data consistently appears as a crucial actor towards the promotion of data literacy across the surveyed literature. A well-connected, healthy society depends on the degree to which government data, such as documents and public records are open and available for citizens (Ahmad & Warriachi, 2020). It is also required a collaborative exchange among educators, journalists, government, NGO's and industry to enhance one's familiarity with the way data is used (Börner et al., 2016; Carmi et al., 2020, Popham et al., 2020; Yoon & Copeland, 2019; Yoon & Copeland, 2020). Given the

growing phenomena of datafication, both the democratization of data and the participation of citizens in the data infrastructure are flagged as the optimal way moving forward (Gutiérrez, 2019; Markham, 2019). Data facilitates the mapping of who one is and what one can, may and (probably) will do. Therefore, decisions emerging from people's data should not be solely made by governments and organizations, particularly in the social media spectrum. Tech-giants must face increased competition, giving users better options (Krutka et al., 2020), although the former's quest for monopoly considerably hinders any effort in that direction. Regardless of how the (big)tech competition milieu evolves, state regulation must ensure stricter enforcement of EU laws on data protection, privacy, and disinformation, increasing accountability of big tech organizations. Mediated by a macro legal framework, the development of clearer "technoethical standards" (Krutka et al., 2020) can emerge from organizations in the form of policies and regulations to promote ethical behaviours as well as from citizens themselves. According to Fernando and Scholl (2020, p.7), "it is important to understand how healthy online social norms, practices and values can be established to reframe the value attached to data and sustain the integrity of socio-technical interactions".

Adopted by over 250 governments (World Bank, 2017), open government data (OGD) may help inform policies, such as Estonia's successful OGD ecosystem and Canada's Open Data Portal. There is still, however, some doubt in terms of the latter's impact on the Canadian public, and improvement in searchability, discoverability, and metadata for users are highlighted as fruitful possibilities (Boychuk et al., 2016). Although thus far there have been limited empirical studies on the impact of open data on deliberative processes and democratic constellations (Ruijer & Martinius, 2017), some identified challenges include: data skills, representation and diversity (ibid), as well as copyright issues, lack of data literacy, accessibility, digital divide, and mismatch of information (Ahmad & Warriachi, 2020). Researching the Swedish municipality of Växjö, Golub and Lund (2021) found a series of useful data sets emerging from OGD platforms, such as sustainability and environment, preschool and school, and municipality and politics. Such data sets can be used not only for research and development towards policy enactments, but also in relation to education, informing citizens' personal choices and creating services. The need for educating target user groups on data literacy also emerged (ibid). Modern local governments must explore how to make their data open, how to learn about which types of data will be most relevant for their end users, and what societal future demands emerge (Ahmed et al., 2019; Gebre & Morales, 2020; Nguyen, 2021; Golub & Lund, 2021).

Yet within the OGD perspective, the differentiation between the use of data by internal experts and external users is of paramount importance towards meaningful civic engagement. Ideally, the use of interactive approaches between a data organization´s context and a user's context may contribute to a more robust engagement between those actors (Gebre & Morales, 2020). Additionally, the use of metadata can be further improved. Currently, the release of open data brings a description of what the data represents, whereas the purpose and possible applications of the data can also be included (ibid). With regard to data mining, Kennedy and Moss (2015) advocate seeking enhanced social understanding and debate on data mining practices. There is a demand for data mining to be accessible to all social groups, particularly marginalized ones; and transparent, therefore available for public scrutiny and government regulation (Gray et al., 2018).

3.2. Institutional approaches to data literacy

The call for community engagement and the focus on the need of open data and OGD training are consensual in the literature (Ahmad & Warriach, 2020; Ahmed et al., 2019; Coughlan, 2019; Fotopoulou, 2020; Gebre & Morales, 2020; Gutiérrez, 2019; Yang & Li, 2020). The development of capacity building programs ought to be an effective measure to nurture proactive participators in public decision making as well as to help in dealing with more complex data sets (Ahmed et al., 2019). From a pedagogical perspective, a well-equipped education sector helps reduce "barriers to public engagement with open data" (Coughlan, 2019, p.25).

The review results show that educational institutions are key actors towards a data literate society (Atenas et al., 2020), albeit the consideration of open data in schools and universities is still embryonic (Gebre & Morales 2020). Becoming data-literate depends on the understanding of the political and socio-economic context and why and how organizations deal with data (Fotopoulou, 2020). Atenas et al., (2020, p.7) advocate the adoption of a critical approach to data literacy in order to "empower educators and learners to be co-producers of knowledge". Authors highlight the need of turning data into an "ordinary object in civic involvement" (Gutiérrez, 2019, p.15), and equipping learners and educators to critically reflect on biased metrics, unethical use of data and privacy violations (Atenas et al., 2020). A number of organizations already work on these issues, such as Medialab-Prado (providing a medium for an exchange of ideas among stakeholders on data projects), España en llamas and DataKind (where data scientists work voluntarily with social organizations), as well as Data Science for Social Good (where scientists are trained to deal with social issues) (Gutiérrez, 2019, p.15). It is envisaged an approximation between all stakeholders, nurturing connections where experiences and knowledge in relation to data are shared.

There is a scholarly consensus as to what constitutes the key institutional commitment: to use open data as a resource for developing data literacy in schools, universities, and other learning spaces, encompassing educators, learners, and administrative staff. In the following sections, based on research conducted within diverse educational projects and teaching settings, we present a series of literature-based recommendations for educational institutions: (3.2.1) following a multidisciplinary approach; (3.2.2) teaching & learning; (3.2.3) establishing connections with external actors; (3.2.4) offering data literacy workshops for citizens & using libraries; and (3.2.5) doing more research.

3.2.1. Following a multidisciplinary approach

As the review illuminates, the presence of data literacy across the curriculum is imperative. Following the premise that data literacy is both a requirement for, and a trigger of making the most of open data, Coughlan (2019) highlights the potential of the latter to enable the development of "authentic and relevant material" (p.25) across a plethora of subject matters. This in turn would expand the possibilities for learning activities and social engagement – especially if the user's personal interests are considered. According to François et al. (2020, p.9), students "need to learn to work and think with data from an early age, so they are prepared for the data-driven society in which they live." The potential of data literacy to influence approaches across subjects resembles that of "writing" across the curriculum in the 1970s, which persisted in various forms throughout higher education (McLeod, 1989 as cited

in Hampton et al., 2017). Writing as a skill was integrated into many university courses, allowing students not only to understand disciplinary material but also to reach success – regardless of their chosen professional pathway (Hampton et al., 2017). As for data literacy, however, one major barrier for the challenging implementation of an interdisciplinary curriculum is the current departmentalization of knowledge into different disciplines (ibid).

Given the inherent complexity to adopt a curriculum-wide approach, a "useful interim step" (Hampton et al., 2017, p.9) would be the implementation of a data related stand-alone university subject/discipline, albeit there is a risk of such an approach being "too generic" for specific learning objectives (ibid). As demonstrated by Hampton et al., (2017), a good example was the implementation of a discipline on data skills, which early exposes students to the thematic and encourages further learning via their networks. Another institutional interim step is the provision of workshop resources and events related to data intensive training, reaching a wider audience and avoiding inequality between those students who have data skills and those who have not. Following the idea behind the existing "writing centres" at many educational institutions, the implementation of "quantitative learning centres" acts as a feasible and effective solution to enhance data literacy and quantitative skills across the curriculum, particularly through a combination of structured and ad hoc tutorials. In addition, the open provision for students and staff of short courses and online resources, including data-discovery tools, example data sets, code, and instructional materials is recommended (ibid).

3.2.2. Teaching & learning

Open data can generate authentic learning experiences, as it is derived from societal and organizational practices. Teaching and learning data literacy imply making data usable, despite the responsibility for making it usable for education being unclear (Coughlan, 2019). There is an important link between education and open data initiatives, which could augment engagement from educators and learners: the goal is to utilize "motivations and personalisation towards real world impact from learning to create shared artefacts and communications that improve the potential to use open data" (Coughlan, 2019, p.24). Moreover, educators, learners, and educational technologists could "build a layer of support and translation on top of original data sources that makes them adequate to teaching" (ibid).

Raffaghelli and Stewart's (2020) systematic review on data literacy in higher education shows that the majority of approaches to educators' data literacy concern management and technical abilities, while ethical and personal approaches to datafication in education are scarce. The success of data literacy will depend on how well information professionals are trained and how aware faculty and administrative staff are in terms of the importance of data literacy: teaching staff need to be data-literate themselves if they want to teach related subjects effectively (Koltay, 2015). Programs to raise awareness of data-intensive skills among more established researchers are recommended (Hampton et al., 2017). Data-intensive training is potentialized by effective coordination, allowing for the "discovery of training opportunities and the sharing of materials, lessons learned, and convergence on standards such as training-effectiveness assessment instruments". (Ibid, p.9). Furthermore, it is crucial to share the structures, created data, and outcomes devised in educational activities using open data, as the latter is "rarely devised for educational purposes, and are often poorly specified" (Coughlan, 2019, p.24).

Institutions are advised to offer (a) curriculum for open data literacy and expertise, (b) practical field experiences & mentoring, and (c) continuing education and outreach (Ahmad & Warriach, 2020, p.9). In the context of data literacy initiatives in universities, schools and training programs, the following emergent components from critical literacies for a datafied society are indicated to integrate the curriculum (see Table 2).

Table 2

Components from critical literacies (Atenas et al., 2020, p.8)

Data ethics: the morally responsible uses of data, caring for people and society adhering to the principles of human rights and personal data protection.
Data politics: the political aspects of data including ways in which data are collected, accessed and displayed by the governments, and how these data are used to foster participation and policy making;
Data governance: the policies and regulations in place for deploying and presenting data in regards with its accessibility, usability, integrity and security-based data standards, norms and laws;
Data management: the process of acquiring, validating, storing, protecting and processing data, in order to ensure its accessibility, usability, integrity, security, reliability and timeliness, and to enable users to search, retrieve, appraise, assess, mine, prepare and clean for analysis;
Data analysis: the processes and methods in which data are collected, organized, assessed and studied to obtain and extract useful information from it;
Data narratives: methods such as data journalism techniques and data storytelling that provide an innovative yet rigorous way to communicate research beyond scientific and technical endeavors in an accessible way to inform wider audiences;
Data visualization: the process of transforming data into visual models to make information understandable and informing to support decision-making or comprehension of processes and phenomena) (Atenas et al., 2020, p.8). Data visualization reading and writing skills should be offered in formal and informal education settings (Börner et al., 2016, p.13).

Social media skills, which are closely related to the above-mentioned emergent components from critical literacies (Atenas et al., 2020), encompass not only how to safely and effectively interact with social media platforms but also how to exercise civic engagement. Social media organizations have the responsibility to elucidate to the public (1) how the business operates, and (2) what it is selling (Krutka et al., 2020). Acting collectively, students can exert agency on social media companies, seeking to "pressure, lobby and regulate" the latter (ibid). Analysis of survey data from an international sample of 148 pre-service teachers has shown that the latter recognize both educational and distracting possibilities in the social media realm, but lack appropriate knowledge as to important policies and regulations (Marín et al., 2020).

Additionally, Gascó-Hernández (2018) suggests that OGD training can maximize OGD usage. As awareness of what OGD is would not suffice to promote its use, introduction and analysis skills need to be taught in combination. Furthermore, effective training on OGD include knowledge

about the context and interactions with the government. Students must understand how to make the data useful in relation to the users' interests. It is therefore paramount to formulate the training interventions considering specific contexts and tailoring the content to the particular characteristics, interests, and expectations of different types of users (ibid).
Offering some form of revised statistical literacy is also key (Gray et al., 2018; François et al., 2020), as Big Data leads to the "irrelevance of statistical reasoning" (Gray et al., 2018, p.10). Future statisticians must be prepared to engage with professionals engaged in data, such as mathematicians (ibid). The development of technical and statistical skills can be complemented with field trips, infrastructure ethnography, projects, readings and experiments in participation "to highlight the various arrangements implicated in the making and social life of data" (François et al., 2020, p.8).

3.2.3. Establishing connections with external actors

The review results demonstrate that community participation in public affairs is paramount for data literacy. Therefore, it can be stimulated by, as follows (Gronlund & Janssen, 2015 as cited in Ahmad & Warriach, 2020):

- Engaging appropriate stakeholders via the offer of easy-to-understand contents;
- Formatting appropriate outreach initiatives;
- Processing user feedback on the artefact;
- Organizing capacity building programs;
- Providing additional tools for data processing;
- Offering mentoring or financial support;

The identification of shared goals for cooperation between educators and open data actors lead to tools and initiatives that make open data more usable (Coughlan, 2019). Data publishers can support data literacy initiatives also in schools via the inclusion of school and education relevant datasets in their portals, as well as making the resources understandable for non-expert users, such as teachers and students. Data custodians can also run workshops for teachers as part of professional development programs to develop teacher's use of data in their teaching. Furthermore, "informediaries can reorganize and/or annotate open datasets by adding relevant information for purposes of learning and instruction" (Gebre & Morales, 2020, p.14).

3.2.4. Offering data literacy workshops for citizens & using libraries

Rather than solely promoting the reassignment of resources to teach data literacy in educational institutions, the implementation of workshops is envisaged to "teach citizens how to work with Open Data" (Boychuk et al., 2016, p.18). In addition to facilitating data literacy learning, such "citizens workshops" also serve as a medium for understanding how people engage with data, how they learn to use and understand a series of devices and applications, and what their interaction with data "means to their lives and in their communities" (Carmi et al., 2020, p.17). The scope of those workshops is advised to be broad, going beyond educational institutions and bringing other social, government and business organizations to closely participate in the process. Ideally, the workshops are set to run on an ongoing basis in order to update participants on the "new emerging media changes" (ibid).

Following the trend of increasing availability of "community-level data" (Copeland et al., 2020, p.15), scholars observe how public libraries must prepare for the provision of services related to data access and reuse, as well as offer data literacy opportunities to graduate and undergraduate students (Quill, 2018; Schuetz et al., 2020). The following courses of action are indicated: organizing the library's data sources for optimal ease of access; partnering with local agencies or universities to provide data literacy instruction (ibid); re-skilling library staff on data literacy (Koltay, 2015; Usova & Laws, 2021); as well as on-going improvement in the use of ACRL (Framework for Information Literacy for Higher Education) (Appel, 2019).

3.2.5. Doing more research

Scholars flag some possible future research venues on data literacy, such as the exploration of how the relationships between data, visualization, and teachers comes into existence, focusing on the effects generated by those practices (Burnett et al., 2020, p.21). It is also relevant that online learning objects are based upon web accessibility standards. Given the inequality among different populations in relation to key literacies and competences, future research on the creation of "inclusive geospatial information instruction curricula, content, and practices is needed" (Appel, 2019, p.17). From an OGD perspective, it is valid to investigate the relationship between specific user's needs and the related skills in the training (i.e., the content of the training programs). Despite evidence that OGD training increases OGD usage, training alone would not necessarily imply usage (Gascó-Hernández, 2018). A systematic and detailed evaluation of short- and long-term impacts of OGD training is thus required. In addition, the following studies are beneficial to be conducted: an exploration of users' motivations to enrol in data literacy training programs (Gascó-Hernández, 2018); an investigation of the correlation between users' motivations to enrol in data literacy training programs – and the different challenges encountered (ibid); and an assessment and evaluation of training approaches for data-intensive research skills in science (Coughlan, 2019).

In what follows, we summarize the key data literacy policy recommendations emerging from our hybrid systematic review, which blended elements from mapping reviews with that of narrative reviews (Ferrari, 2015; Grant & Booth, 2009).

4. CONCLUSION

Open access and transparency are key issues for data literacy to be enacted at state level. Modern local governments are advised to explore how to make their data open and learn about the most relevant types of data for end users. State regulation must ensure stricter enforcement of EU laws on data protection, privacy, and disinformation, increasing accountability of tech giants and start-ups. Promoting data literacy will require state funding, therefore educational institutions need financial support for the design and delivery of data literacy initiatives. Scholars agree that institutions must infuse data literacy related subjects across the curriculum via their structures or programs, following a multidisciplinary approach and offering practical field experiences and mentoring. The use of Open Data and Open Government Data in teaching & learning data literacy related subjects is frequently indicated to equip educators and learners to critically reflect on biased metrics, unethical use of data, and privacy violations. Furthermore, the establishment of connections with external

stakeholders, such as adult education providers and NGOs, can stimulate community participation in public affairs, making the data literacy related resources understandable for non-expert users. Another crucial point for the promotion of data literacy is to offer data literacy workshops for citizens, examining how people engage with data, how they learn to use and understand a series of devices and applications, and what their interaction with data means to them. The review also shows the need to conduct further empirical research on data literacy, such as on assessment of data literacy related activities.

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