PRE-PRINT – Please cite as

Raffaghelli, J. Developing a Framework for Educators' Data Literacy in the European context: Proposal, Implications and Debate. Proceedings of the 11th International Conference on Education and New Learning Technologies, Palma de Majorca, Spain, 1-3 July 2019, pp. 10520-10530. DOI: 10.21125/edulearn.2019.2655

DEVELOPING A FRAMEWORK FOR EDUCATORS' DATA LITERACY IN THE EUROPEAN CONTEXT: PROPOSAL, IMPLICATIONS AND DEBATE

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Abstract

This article introduces conceptual framework supporting educators' data literacy to empower them as education professionals, as well as their students, to thrive in the datafied society. By framing the problem, we are putting the basis for educational intervention.
The study is based on a conceptual review of several frameworks of data literacy. Over a search of 386 papers, 19 papers were selected, aiming at discussing, developing or testing data literacy frameworks. The frameworks' components were extracted, analysed and discussed through a comparative approach. From the analysis of the background and the dataset, it emerged that the topic of data literacy is not new and has a tradition of research linked to numeracy as basic literacy. More recently, statistical elaboration, visualization and data storytelling; perspective on data to empower learners, personal and critical data literacies, as well as the use of Open Data as Open Educational resources to promote both technical skills as well as civic education has also been given increasing attention. In spite of this emerging characterization, the discussion connected to educators' data literacy is mostly focused on evidence-based approaches, and the several problems dealt in the literature on data literacy are not comprehensively covered into a single framework. On these basis, and considering the policy recommendations of the DigCompEdu as framework for educators' digital competence, the article introduces a proposal to frame data literacy as crucial dimension of educators' professional competence.

Keywords: Data Literacy, Educators' Professional Development, DIGCOMPEDU.

1 INTRODUCTION

Education systems have been dragged to processes of datafication in an effort to survive a crisis of credibility. This phenomenon has taken place along the emergence of large amounts of digital data, the DNA of information in the contemporary society. The most enthusiastic discourses on the abundance of data have emphasized the opportunity to generate new business models, new professional scenarios related to data science and open practices in science and government [1]. More recently, the rather naïve logic of capturing and articulating data through various algorithms, as a driver of economic and social innovation such as the selection of workers, the incentives to teachers for their professional practice or the inclusion in waiting lists for granting mortgage loans, has been criticized and deconstructed [2]. The evidence-based education policies [3], as well as the progressive digitalization of processes and services have created a culture of data-driven practices [4], [5]. Initially, there were intense discourses that supported the practices based on big data as an opportunity to improve efficiency, objectivity, transparency and innovation [6]. However, today in this area there have also been numerous criticisms and concerns regarding how "datafication" could imply, for example, an unethical use of student and teacher data. However, the paradigm of open science, based on participatory schemes in which citizens are invited to explore and contribute more closely throughout the cycle of data collection, are the side of the coin. The openness and reusability of research data indeed could accelerate scientific collaboration and discovery in unprecedented ways and education

could enhance these trends. At the intersection between these two changing worlds, the educational practice could potentially address new connections between research and teaching through the use of educational data as content and for the advancement of teaching as part of educational science [7]. Despite such promising scenarios for data-driven practices, the implementation of these innovations in research and teaching involves both professional reflection and the need for a critical approach [8].

2 BACKGROUND

There are numerous competency frameworks related to the technical skills in data science to be promoted among students [9]. The skills required to work with math concepts as well as for very basic statistical elaborations as part of basic education and as life skill has always been present in the educational debate. However, the frameworks place the areas of knowledge in diversified ways and the terms adopted encompass polysemy. The concept of numeracy appeared first in 1959, year in which the report Crowther from UK [10] included this term in the general context of basic literacy. Along its history, the term acquired several meanings and entered in national guidelines for literacy, taking into account the growing importance of STEM studies for the productive systems and for innovation. The term initially spotted math competence, that is, the progressive ability of counting and undertaking simple arithmetical operations not only in scholastic contexts but also as part of daily life. With its growing relevance, the term was included in the famous international studies PISA – Programme of International Students' Assessment- and later on in the PIIAC -Programme for the International Assessment of Adult Competencies- [11], [12], being defined as: critical reasoning; communicating, modelling, problem solving, representing with numerical information; using the symbolic, technical and formal language of the mathematical operations; use of instruments connected to mathematical operations. In the more recent definitions of PISA and PIIAC there is a clear attempt to move beyond the concept of mathematical skills as knowledge of formal procedures within arithmetical and algebraic operations, towards applied concepts in authentic environments requiring problem solving skills. Moreover, according to Gould (2017) in the contemporary society it is necessary to achieve skills to interact with statistical information, more and more present in all sort of textual reports, magazine articles and other social productions. This author mentions the *statistical literacy,* which in the literature is considered within numeracy but as specific area where some of the problems are: to understand the concept of sampling and error sampling; the differences between correlations and causality and the risks of assuming the first as the second; the difference between descriptive and inferential statistics. However, the same author prevents that currently the term *statistical literacy* could be insufficient to cover a number of phenomena. In fact, on the basis of new forms of data collection based on crowdsourced and digital data, the paradigm of inferential statistics is giving way to new forms of data analysis based on algorithms and the concept of Bayesian probability. Algorithms that aggregate news and product's preferences, are based on decision trees and Bayesian probability models; they are a daily, yet often unknown, users' experience. Hence, Gould points out that the term of *data literacy* could cover better these emerging phenomena. However, neither within this term there is agreement. Data literacy could be said focused on activities that would be carried out in formal contexts, particularly those related to the teaching of science and mathematics [14]. The debate in the context of information literacy has laid the foundations to suggest richer approaches, beyond formal learning, considering not only cognitive but also ethical and creative aspects [15] In the review of the literature by Maybee & Zilinski [16], based on the analysis of 8 data literacy frameworks, in which they identified the following elements: a) Awareness: understand what data is and what its role for society is; b) Access: understand how to identify, locate and correctly use data sets and databases; c) Participation: evaluate, analyze, organize and interpret existing data and make decisions based on them; d) Administration: plan and manage data, including organization and analysis, security protocols for storage, exchange and associated documentation; e) Communication: synthesize, create visualizations and data representation; f) Ethical use: identify diversified data sources, in particular related to human and social activity, considering the risks of administering said data, understanding the implicit issues in its use; g) Conservation: to know the forms of security in the short and long term, in relation to the storage, use and reuse of data. The approaches have not been formulated only from the field of research: as the phenomenon of datafication grew, but components and approaches have been added. For example, from the movement of open data, interpretations have emerged about the skills needed to operate in the sector. An example is the "Open Data Skills" framework, generated by the Open Data Institute (ODI), an organization that promotes advanced training in the areas of data science and basic professional skills, which categorizes users according to the following levels of work with data: a) Explorer: who has a basic understanding of the data. At this level you can define the data to work with, indicate examples or case studies and explain how the data can be used to create a change; b) Professional; that performs basic operations on an open data

set. You can browse the data and know the tools and techniques necessary to manage and publish a set of open data; c) Strategist: that integrates open data into a strategy or manages an open data project. Learn the planning and management techniques to carry out an open data initiative and understand the challenges inherent in this process; d) Pioneer: who possesses skills and knowledge that allows them to solve challenges in their sector. You can indicate specific case studies by sector, identify future trends in the sector and understand how to use the data that best fits the production challenges specific to your sector. In a second phase, the ODI has produced an interactive framework that goes beyond the levels of competence to focus the areas and contents of training in data science in professional contexts. In these cases, they have aimed to form basic skills of introduction to the use of data, its publication, management, production or development based on big data or open data, and analysis and leadership of business models. However, for the ODI, these competences could be assets of an organization, not necessarily of a single worker, therefore, their training offer and the related framework is part of an organizational development plan as an "organization based on the data science. As can be inferred, this framework refers to professional skills, which can create a prospective scenario for the development of data literacy from the earliest stages of training, while continuing education initiatives focus more as a final goal.

Data literacy has also been debated in connection to the educational process. For about 20 years the research on school management has shown a perspective on the use of data to inform educational planning practices and the improvement of pedagogical practice [17] that have been broadly related to the evidence-based education model (Evidence-based Education, [3]). In Higher Education the debate of data usage could be related to learning analytics and its multiple developments, where the data literacy of teachers and students is equivalent to understanding the data-mapping systems, the algorithms used to generate diagnostic tables, and prediction of behaviors in a learning system, and the reading of graphical interfaces (dashboards) with visual analytics. In fact, the data coming from learning and teaching is being collected on an unprecedented scale, leading to the mining of educational data and, in particular, to learning analytics [18]. While there is no doubt about the value of learning analytics to support the pedagogical practices of teachers and student self-regulation [19], assumptions about the power of algorithms to predict, support or improve educational processes can become practices of discrimination and surveillance without adequate control [20]. In this sense, data literacy would be related to a kind of pedagogical literacy, that is, to the translation of data collected in pedagogical constructs and processes [21]. Moreover, another focus on data literacy has focused the problem of surveillance in all digitally mediated human activity. Pangrazio and & Selwyn [22]have claimed the need to implement forms of literacy in personal data that allow the user to have greater control not only in the way in which their data are plotted, but also in the way in which they interact with a system to augment or decrease the production of data as “oil” of a trading system. In spite of the rich debate on data literacy as learners’ skills, educators’ data literacy seems to be less developed, with more research dealing with K12 teachers and the school system, and less considerations relating to other educational levels (such as higher education and lifelong learning). Data literacy should be integrated into the general concept of educators’ professional competence, which includes, inter alia, their professional practices, working conditions and their identities in the context of a datafied society and education systems. The incomplete coverage of the topic could be due to the fact that the problems related datafication in education are diversified, and positioned at the intersection of data as content of education and data along the pedagogical practice (Raffaghelli, 2018a). To this regard, a framework covering education data practices in a more complex, critical and broader way could address smarter data literacy coverage.

3 METHODOLOGY

In this paper our aim is to review the literature on data literacy frameworks to develop instruments addressing educators’ professional development. In this context, we will adopt the word educators in a broader sense, covering several profiles engaged in lifelong learning: from early education and care, to teachers, to faculty, to adults’ educators and trainers. of teaching, as discussed above. The research question that has guided this conceptual exploration has been: *How should the professional development of educators be designed and developed to introduce a transformative and critical use of digitized data and ensure a positive impact on data literacy (Data Literacy - DL) as an essential component in contemporary education systems?* This research question is very broad and raises a research work that requires not only the identification of components to be formed, but also experimental interventions addressing professional development processes with their implications for organizational development and the impact on university students. However, the definition of constructs and competence frameworks is a fundamental exercise for the successive implementation

of activities in the field. As for the literature review method, we adopted the conceptual review. According to [23], this type of review groups articles according to concepts, or categories, or themes with the aim of identifying the current 'understanding' of a given research topic. In our case, the topic focussed has been data literacy frameworks, where the components, approaches and focus on data have been identified in an attempt to determine the key, emerging components of a new framework for educators' data literacy. Therefore, by providing a snapshot of where things are with the field of research of data literacy frameworks, it puts the basis to launch an instrument for educators' data literacy. For the selection of papers, we sought on four scientific databases which index peer-reviewed research: SCOPUS (www.scopus.com), ISI-WOS (www.webofknowledge.com); ERIC (https://eric.ed.gov/); DOAJ (www.doaj.org). As for the search terms, a broad approach was adopted, using *"data literacy" AND "teacher" OR "educator" OR "faculty".* Over 386 papers found, once the ovelaps were eliminated, only 138 papers dealt specifically with data literacy through empirical or conceptual analysis within the context of education. From these, the more exclusive criteria of introducing data literacy frameworks or having as main goal to discuss data literacy frameworks led to 19 final papers.

4 RESULTS

4.1 Conceptual Review

The closer analysis of the 19 articles discussing frameworks for data literacy showed that the studies spread along the several levels of education, with 10/19 (53%) of papers presenting research done and applicable to HE; 4 (21%) from/to K12; 2 (10%) from/to Teachers' Education; 2 (10%) to Professional Learning and the remaining study (5%) which could be applied to Lifelong Learning. As for the research methods adopted in the several selected studies, 6 (30%) studies were Conceptual (discussing, analyzing and synthesizing concepts over data literacy); 1 (5%) study did Content Analysis to extract the several dimensions of data literacy; 5 (26%) studies were based on Design-Based Research, namely, implementing non controlled experimental activities in class; 2 (10%) studies based on Documentary analysis and literature reviews; 3 studies based on surveys and 1 study based on interviews. Since we classified the papers taking into consideration the type of focus on data within educational activities, we got an overall picture on how data literacy was studied as well as the type of expected applications. In this regard, "Data in Teaching and Learning", more connected with achieving basic to higher levels of data science (extracting, processing, generating complex visualizations/graphs), was a prevalent focus with 7 cases (37%); however, another equally significant focus (with 6 cases, 31%) was "Research Data Management" which defines data literacy as the ability to data management as process of data curation, treatment, presentation and sharing along academic activities (students' research projects to researchers' advanced stages of activity). These two prevailing approaches were followed by data literacy seen as instrument to "Empower Learners" (4 studies, 21%). The empowerment has place as a form of "meta-learning", that is, using data to understand processes into which the learners are engaged, from political and socio-cultural activities to pedagogical processes (the case of learning analytics' usage). Lastly, 2 studies on data literacy frameworks were characterized as "educational data management" since their focus related teachers' data-driven practices to improve the quality and effectiveness of school education (K12). As for the framework components, which are synthetically introduced in Table 1, the further level of detail allows to see the convergent and divergent elements.

Table 1- Analysis of 19 Data Literacy Frameworks.

The dataset with the analysis as well as the full references can be found in an Appendix downloadable at: https://bit.ly/2ViDOlp

Authors	Framework components	Focus on Data
[1]Harris, Berkowitz, & Alvarado, (2012)	Knowledge of ecological ideas, motivation and engagement in science, data exploration, and citizenship skills	Data in Teaching and Learning
[2]Starobin & Upah (2014)	Mixage of two guiding conceptual frameworks: 4Vs of Big Data (Rajan, 2012) Volume, Velocity, Variety, and Veracity to organize, store, manage, and manipulate vast amounts of educational data. Conceptual Framework of Teachers Data LIteracy by Gummer & Mandinach (2013) - Collection, examination, analysis, and interpretation of data to inform some sort of decision in an educational setting.	Data in Teaching and Learning

[3]Yarnall, Vahey, & Swan (2014)	Preparation for Future Learning (PFL) framework in the use of layered and parallel data representations. PFL:	Data in Teaching and Learning
[4]Schildkamp, Kim Poortman (2015)	Data-decision making in education. Several data characteristics (access and availability of high quality data), school organizational characteristics (a shared goal, leadership, training and support, involvement of relevant stakeholders), and individual and team characteristics (data literacy, pedagogical content knowledge [PCK], organizational knowledge, attitude, and collaboration) influence the use of data in data teams.	Educational Management
[5]Koltay (2016)	Big data understanding, data sharing, data quality, data management, data curation, data citation, data interpretation	Research Data Management
[6]Maybee & Zilinski (2015)	How data are used to learn and communicate within disciplinary learning contexts: data informed learning as a framework	Data to Empower Learners
[7]Gummer & Mandinach, (2015)	Teacher data-informed practice: three interacting domains (data use for teaching, content knowledge, and pedagogical content knowledge), six components of the inquiry cycle (identify problems, frame questions, use data, transform data into information, transform information into a decision, and evaluate outcomes), and, finally, 59 elements of knowledge and skills embedded within those components.	Educational Management
[8]Duffner-Ylvestedt, Nadja Rayner (2016)	data management as process of data curation, treatment, presentation and sharing along academic activities	Research Data Management
[9]Wasson, Hansen, & Netteland (2016)	Configuration of technology tools supporting LA; tools' for data generation; data analysis; pedagogical interpretations of data; sharing pedagogical data interpretations	Data to Empower Learners
[10]Aoun (2017)	“Humanics” as emergent interdisciplinary approach including are data literacy, technological literacy, and human literacy.	Data in Teaching and Learning
[11]Borges Rey, (2017)	Understanding data beyond the process of data production, namely: a) as capable of secondary agency, b) as the vital fluid of societal institutions, c) as gathered or accessed by new data brokers and through new technologies and techniques, and d) as mediated by the constant interplay between public and corporate spheres and philosophies.	Data in Teaching and Learning
[12]English & Watson (2018)	A modelling framework comprising four components: working in shared problem spaces between mathematics and statistics; interpreting and reinterpreting problem contexts and questions; interpreting, organising and operating on data in model construction; and drawing informal inferences	Data in Teaching and Learning
[13]van der Wal, Bakker, & Drijvers (2017)	Techno-mathematical literacies (TmL) as data literacy, technical software skills, technical communication skills, sense of error, sense of number, technical creativity and technical drawing skills.	Data in Teaching and Learning
[14] Wiorogórska, Leśniewski, & Rozkosz, (2018)	Data management as process of data curation, treatment, presentation, preservation and sharing along academic activities	Research Data Management
[15]Zhang, Lin, & Xiao (2018)	Data Competence Framework: understanding data types, drawing up a data management plan; collecting data; processing data; analytic statistics by using SPSS and Excel; using NVIVO to have qualitative analysis; having consciousness to preserve data in the future; understanding the method to preserve data; reusing consciously or normatively data.	Research Data Management
[16]Rudžionienė, Grigas, Enwald, Kortelainen, & Kortelainen, (2018)	Data management as process of data curation, treatment, presentation and sharing along academic activities	Research Data Management
[17] Zhang (2018)	Getting, analyzing, managing and using data by users, so as to improve the ability to use data in life and work	Research Data Management
[18] Pangrazio & Selwyn (2019)	Beyond technical data literacies: (1) Data Identification, (2) Data Understandings, (3) Data Reflexivity, (4) Data Uses, and (5) Data Tactics.	Data to Empower Learners
[19] Atenas, Havemann, & Priego (2015)	Open Data as key in the development of transversal skills (including digital and data literacies, alongside skills for critical thinking, research, teamwork, and global citizenship), enhancing students' abilities to understand and select information sources, to work with, curate, analyse and interpret data, and to conduct and evaluate research.	Data to Empower Learners

As highlighted through the classification by “focus of data”, we observe that data is seen as: 1) authentic resource for teaching learning, encompassing skills to extract, process, analyze, visualize, comment, communicate and share data, from basic (K12) to higher levels, and particularly applied to STEM –Science, Technology, Engineering and Math (see the table 1, cases 1-3,10-13) ; 2) the constituent element of research as scholarly activity, where data management including data curation and preservation, and the role of librarians supporting the activity are relevant (cases 5,8,14-17); 3)

data as the base for decision making in school management, where the teachers are the key players and their activity not only in teaching and learning but also in teaming up for data informed organizational development are the main concerns (4,7); 4) data as resource to support people understanding, engaging and participating in social processes, including pedagogical activities, where data supports meta-cognition, self-regulation, and at higher level, critical thinking and emancipation (6,9,18,19). We also observe that adults' education and data literacy connected to open government data is never considered in the frameworks. The emergent picture shows a field where data literacy is characterized only partially as it regards to educators' competences, with only the 3 group of studies explicitly focusing educators' data literacy, but narrowly spotting teachers' data use for school management and educational evaluation. As a result, we can claim for the need to develop a broader framework for educators' data literacy, which includes the four components yielded from our categorization of studies.

4.2 Setting a framework for educators' data literacy

In this exercise, we could introduce the European debate on the Digital Competency framework, DigComp 2.1. [24] in connection to the DigCompEdu [25]. While the scope of these two frameworks is broader than data literacy, our interest will be placed on the idea of having a specific framework to address educators' digital competence over the basis of having developed a basic framework for learners. The aim of this operation will be integrate the picture got through the literature review, with a critical understanding of two instruments connected to regional policy recommendations, so as to address educational practices on both research and policy basis. Elaborating on the digital competence placed within the "Key Competences for Lifelong Learning" (European Commission, 2007), the first DigComp framework was born in the context of the actions of the European Digital Agency 2020 and responded to the great need to qualify and generate qualified digital environments for all European citizens of all ages. A new version was published in 2016 (2.0); However, the change that most interests us is that of the last update of 2017 (2.1) in which, under the heading "Information Literacy", the element "Data Literacy" is added. The new framework offers not only the definition of competences, but also provides a series of scenarios in which these competences should be applied and which demonstrates their achievement. Therefore, this structure should allow the evaluation of digital skills in its 8 components, including the aforementioned data literacy. However, careful reading of the entire model and of this subcomponent, as well as the situations considered for its evaluation, seem insufficient to cover all the richness of data literacy in the components that we have described previously. In fact, in DigComp 2.1. we talk about data literacy in terms of: (1.1.) Explore, search and filter data, information and digital content (in the DigComp 1.0 version: browse, search and filter information); (1.2.) Evaluate data, information and digital content (in the DigComp 1.0 version: evaluate information); (1.3.) Manage data, information and digital content (in the DigComp 1.0 version: Store and retrieve information). But in these three subcomponents, none of the ethical, creative and constructive aspects of data literacy appear. In fact, while the DigComp 2.1. offers areas of successive analysis that could provide space for the most creative forms of data literacy, this component is not properly identified and is lost among the many other activities that should be considered in subsequent dimensions. By aligning the dimensions of DigComp with the data literacy elements already analysed, we find that; a) the dimension of communication and collaboration has an example associated with the literacy of data in the processes of documentation and narration with data, that is, data storytelling; b) the creation dimension of digital content, it has associated in data visualizations; c) the security dimension, in the anonymization of data; and finally, d) the dimension of solving problems in complex extractions and statistical elaborations. These elements provide the basis for thinking about a framework of competencies that support data literacy that, although converging with DigComp, must find its space, responding to the training needs discussed in the initial paragraphs. Likewise, the introduction of the DigCompEdu framework, digital competence of educators associated with DigComp, can be discussed when thinking about data literacy of the educators themselves, and in particular of the university teaching staff. The main underlying construct is the development of digital competence educators, linked to open, online and digital practices carried out in their professional activities. Wanting to deal here with a conceptual and operational characterization of data literacy, we must resort to the digital competence frameworks, and in this sense, refer to the DigCompEdu, the analysis of the problem (the need for a data literacy framework) and the review of the literature, to pinpoint to the elements that we need to consider. We argue that the relevance that the four approaches/focus on data can be placed within the six dimensions of the DigCompEdu (Professional engagement, Digital Resources, Digital Pedagogy, Digital Assessment, Empowering Learners, Facilitating Learners' Digital Competence). As a matter of fact, the Professional engagement clearly aligns with Education and Research Data Management; whereas the focus on Data in Teaching and

Learning goes closer to the Digital Resources, Pedagogical Practices and Facilitating Learners Digital Competence. Finally, the focus on Data to empower learners can be placed within the dimension of Empowering Learners. The Table 1 shows the dimensions related to a final and high state of data literacy. This table has taken into consideration the same dimensions of competence of DigCompEdu and has adapted them in relation to the literature review of data literacy models previously presented. Table 2, always associated to the DigCompEdu framework, on the other hand, offers a dynamic panorama of evolution of skills and knowledge. Therefore, aligning with the mentioned framework for educators' digital competence, we offer firstly the educators' data literacy framework, and secondly a gradation of its development as a reference for diagnosis or self-diagnosis of progress.

Table 2- Reference framework for the development of data literacy for educators.

C.D	Descriptor	Description
PROFESSIONAL ENGAGEMENT	Research data practices	Over the full cycle of scientific information, to be actively engaged in open science and advanced critical data practices that are transferrable to teaching, (particularly in Higher Education teaching).
	Organizational communication	To use available data to enhance organizational communication with colleagues, students and third parties. To contribute to collaboratively developing and improving organizational communication strategies and policies driven by data (learning and academic analytics, statistical reports, social media data, etc.).
	Professional collaboration	To use open data approaches in science and educational activities to engage with other scholars, sharing and exchanging knowledge and experience, and collaboratively innovating pedagogic practices.
	Reflective practice	To individually and collectively reflect on, critically assess and actively develop one's own data-driven practices within teaching. To reflect on the connections between the advancement of one's own research discipline and data procedures and those of data procedures and activities embedded into teaching.
	CPD	Continous Professional Learning to cultivate learning ecologies supporting data literacy in pedagogical practices.
DATA AS A RESOURCE FOR LEARNING	Selecting data as a resource for learning	To identify, assess and select data or data approaches as resources for teaching and learning. To consider specific learning objectives, contexts, pedagogical approaches and learner groups when designing data approaches and planning their use.
	Collecting, extracting data as a resource for learning	To modify and build on existing openly-licensed data or data extraction approaches where this is permitted. To collect new data as a resource for learning. To consider the specific learning objectives, contexts, pedagogical approaches and learner groups when designing data approaches and planning their use.
	Managing, protecting and sharing data	To organize data as educational content and make it available to learners and eventually to other stakeholders. To effectively protect sensitive data. To respect and correctly apply privacy and copyright rules to open data. To understand the use and creation of open licences and open data as open educational resources, including their proper attribution.
TEACHING AND LEARNING	Teaching	To plan for and implement data-driven activities and visualizations in the teaching and learning process, so as to enhance the effectiveness of teaching interventions.
	Guidance	To integrate data-driven guidance (based on students' logs, assessments, course evaluations, monitoring processes, dashboards) to offer timely and targeted guidance and assistance. To experiment with and develop new forms and formats for offering data-driven guidance and support.
	Collaborative learning	To use data-driven approaches to foster and enhance learner collaboration. To enable learners to use their own data as part of collaborative assignments and as a means of enhancing communication and collaboration and collaborative knowledge creation.
	Self-regulated learning	To use data-driven approaches (based on students' logs, assessments, course evaluations, monitoring processes, dashboards) to support learners' self-regulated learning, i.e., to enable learners to plan, monitor and reflect on their own learning, provide evidence of progress, share insights and come up with creative solutions.
ASSESSMENT	Assessment strategies	To integrate the data produced throughout the learning process for formative and summative assessment purposes.
	Analysing evidence	To generate, select, critically analyse and interpret data as evidence of learner activity, performance and progress, in order to inform teaching and learning.
	Feedback and planning	To use the data produced throughout the learning process to provide targeted and timely feedback to learners. To adapt teaching strategies and to provide targeted support based on the evidence generated by the digital technologies used. To enable learners and other stakeholders to understand the data as a form of evidence provided by digital technologies.
E M	Accessibility and	To ensure accessibility to the data generated and used during learning activities, of all

	inclusion	learners, including those with special needs. To consider and respond to learners' expectations, abilities, uses and misconceptions on data.
	Differentiation and personalization	To use digital technologies to address learners' diverse learning needs, allowing learners to advance at different levels and speeds and to follow individual learning pathways and objectives.
	Actively engaging learners	To use digital technologies (like data storytelling and the generation of infographics) to foster learners' active creative and critical engagement with data as learning content. To open up learning with data to new, real-world contexts of data usage, involving learners themselves, in hands-on activities, scientific investigation or complex problem solving.
FACILITATING LEARNERS' DATA LITERACY	Learners' data literacy	To incorporate learning activities, assignments and assessments that require learners to articulate the need for data; to support students in finding and extracting raw data in digital environments; to support learners in their organization, processing, analysis and interpretation of data and to compare and critically evaluate the credibility and reliability of available data in the context of their sources.
	Learners' use of data in communication and collaboration	To incorporate learning activities, assignments and assessments which require learners to effectively and responsibly use digital tools to share data.
	Learners abilities of data storytelling	To incorporate learning activities, assignments and assessments which promote learners in the generation of visualizations, representations and stories using data. To teach learners how copyright and licences apply to data as digital content and how to reference sources and attribute licenses.
	Learners' responsible use of data	To empower learners to acknowledge and manage the risks of using personal, social and generally open data safely and responsibly.
	Learners' use of data in problem solving	To incorporate learning activities, assignments and assessments that help learners identify and solve technical problems and data extraction, elaboration and presentation

The same framework and the logic of statements in support of self-evaluation were adopted in the survey in relating the levels of proficiency for each of the above dimensions with areas of competence.

Table 3- Levels of proficiency for the development of educators' data literacy.

Level / Description	PROFESSIONAL ENGAGEMENT	DIGITAL RESOURCES	TEACHING AND LEARNING	ASSESSMENT	EMPOWERING LEARNERS	FACILITATING LEARNERS' DATA LITERACY
C2 Pioneer	Innovating towards a critical perspective of data-driven professional practices	Promoting innovative ways of exploring and using data	Innovating in ways of understanding and using data in teaching and learning	Innovating in ways of understanding and using data assessment	Innovating learner involvement in data-driven practices	Using innovative formats to foster learners' personal, professional and social data literacy
C1 Leader	Discussing and renewing data-driven professional practices	Comprehensively using advanced strategies and resources for exploring and using data	Strategically and purposefully renewing teaching practice by understanding and using data	Critically reflecting on ways of understanding and using data in assessment and evaluation	Holistically empowering learners in data-driven practices	Comprehensively and critically fostering learners' data literacy
B2 Expert	Enhancing data within professional practices	Strategically using interactive strategies and resources	Enhancing teaching and learning activities through data	Strategic and effective use of data-driven assessment and evaluation	Strategically using a range of tools to empower learners in data-driven practices	Strategically fostering learners' data literacy
B1 Integrator	Expanding professional practice through the use of data	Fitting data as a resource to the learning context	Meaningfully integrating data into teaching	Enhancing traditional assessment on the basis of available data	Addressing learner empowerment in data-driven practices	Implementing activities to foster learners' data literacy

A2 Explorer	Exploring data-driven professional practices	Exploring data as a resource for learning	Exploring teaching and learning activities using data	Exploring the meaning of data on traditional assessment	Exploring learner-centred strategies to promote data-driven practices	Encouraging learners to understand data in the taught discipline
A1 Newcomer	Awareness of data-driven practices, uncertainty, basic use	Awareness of data as a possible resource, uncertainty, basic use	Awareness of the problem of data within teaching and learning, uncertainty, basic use	Awareness of the problem of data in assessment, uncertainty, basic use	Awareness on the need to empower learners to understand and use data beyond the discipline, uncertainty, basic use	Awareness of the need to understand data in the taught discipline, uncertainty, basic use

Source. Adapted from Table 8 (DigCompEdu proficiency progression by area), European Framework for the Digital Competence of Educators, 31 [25].

5 CONCLUSIONS

In this article we reviewed a series of issues and problems related to data literacy as an emerging sector of digital literacy, paying particular attention to the problem of the professional development of educators in regard to the phenomenon. The background and the 20 research works dealing with data literacy frameworks here analyzed show a panorama of intense activity that seeks to respond to several productive, organizational and political-social innovation objectives. Precisely because of the multiple lines analyzed, we can conclude that to this day, there is no systematic pedagogical approach that is capable of covering the educators' professional development needs in a programmatic way and tending to unite the various pieces of the current puzzle. In this sense, the effort of conceptual elaboration here purported, requires a reflective activity within the educational community, as well as the careful accompaniment of educational research on new literacies. It is evident that the orientations of professional learning related to datafication have been located at the level of data science, either in the academic or industrial sphere, with a focus on advancing highly required technical needs. However, as can easily be seen, this type of approach is based on the market's pulling logic, which may or may not guide reasoned and scalable approaches in basic and permanent education. As the educational technology sector amply demonstrates, the technological innovations often create enthusiastic and avant-garde movements, and, less frequently, integration or day-to-day actions which actually transform the system and serve inclusive needs and social equity. Beyond a dystopian vision of data in education that emphasizes control, vigilance and lack of ethical concerns regarding data collection [26], processes of awareness and negotiation of meaning based on existing infrastructures could generate practices that would imply continuous professional learning and organizational development towards the appropriation of the phenomenon of datafication. With this in mind, the effort to empower the educators and to keep working on frameworks addressing advanced data practices jointly with their learners.

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