Exploring the Micro, Meso and Macro
Proceedings of the European Distance and E-Learning Network 2018 Annual Conference
Genova, 17-20 June, 2018
ISBN 978-615-5511-23-3
ISSN: 2707-2819
doi: https://doi.org/10.38069/edenconf-2018-ac-0023

OPEN DATA FOR LEARNING: A CASE STUDY IN HIGHER EDUCATION

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Introduction

Nowadays there is increasing public pressure to open the data generated by public administration and the scientific system, being these activities maintained through public funding (Zuiderwijk & Janssen, 2014). In fact, the so called movement of "Open Data" embraces a philosophy of democratization of knowledge that can be considered in line with the prior movements of Open Access and Open Science. The most enthusiastic discourses on the availability of data and the feasibility of appropriation by the civil society are based on politic ideals as empowerment, public engagement and political monitoring, from one side; from the other side, big (open) data can be the base for new business models and crowd-work models towards economic development (Baack, 2015). However, this utopia could be hindered by an already well-known problem in the digital society: the need of skills and knowledge to navigate within the digital abundance that is continuously produced by the digital and open world. Some have compared the problem of appropriation of open data to the phenomenon of digital divide (Gurstein, 2011). As Zuiderwijk, Janssen, Choenni, Meijer, and Alibaks (2012) claimed, for the access to open data become civic monitoring and empowerment, it would be necessary for citizens to have minimal skills that lead them to understand which are the social problems monitored through data and to read the eventual representations already available to formulate new questions (Zuiderwijk et al., 2012). And this would be the lowest level in the analysis and use of public data, if we consider the several data transformations undertaken by statistical experts and researchers (Janssen, Charalabidis, & Zuiderwijk, 2012). This situation is highlighting the fact that the potential embedded in open data could not be directly transformed into effective practices. Several areas of social sciences have started to study the Open Data movement, spotting several problems and opportunities for development: Economics (innovation processes, business models and crowdwork based on open data); Political sciences (e-Government and Open Government, digital citizenship, civic engagement); sociology of science and information sciences (Open Data within Open Science, access to public scientific knowledge, new forms of scholarship in the digital era). However, the issue has been little explored from a pedagogical point of view, that is, the several formal and informal learning processes that could be based on Open Data (Davies, 2010; Raffaghelli, 2017). With some experiences and debates that pioneered reflections, like Atenas, Havemann, and Priego (2015) and their framework for Open Data as Open Educational Resources, the topic's boundaries are still to be defined. In spite of this situation, there is another area of studies that is growing consistently and could bring some light: I refer to the studies on *data literacy* (Stephenson &

Schifter Caravello, 2007) as a base to deal with Open Data. Yet data literacy studies have focused more the definitions of what should be included in this type of literacy, or whether it is a part of information literacy or numeracy, or if it should be considered separately; experimental studies or action research on practices leading to achieve it, are much less frequent (Gould, 2017; Vahey et al., 2012). The panorama seems to require further educational research: from the emerging professional profiles and specialist competences required in the highly qualified positions of *data scientists;* to the basic literacies to deal with data as part of basic and higher education. Educational research should cover areas as competences' frameworks that should the levels of mastery for the several educational levels as well as methods to develop data literacy as life skill as well as highly specialized professional competence. Aligning with the idea of macro, meso and micro dimensions of learning (EDEN Annual conference 2018, Genoa Call – http://www.eden-online.org/2018_genoa/call/), the topic could be explored from the macro level of Open Data as Open Educational Resources: the libraries, their classification and curation; the meso level could focus the problems of learning design and the connected pedagogical methods to adopt Open Data; and the micro level would relate the impacts on data literacy achieved through the use of Open Data. Therefore, in this paper, my aim is to reflect on the problem of data literacy as one of the frontiers of numeracy in the context of higher education and particularly regarding educators as professional category being formed. Hence, I will introduce a case study generated in this context as a mean to reflect over two issues: Firstly, the issue of data literacy as part of academic skills, attempting to understand the several difficulties and motivations leading open data exploration by university students that are not expected to master Statistics or Data Analysis as part of their professional competences; secondly, I wish to reflect on the several problems faced to design for learning with Open Data.

Data literacy: A brief background

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 (UK) 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 – (OECD, 2012; 2017) 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

ISBN 978-615-5511-23-3

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. Actually, in the Canadian report of 2015 promoted by the National Council of Human and Social Sciences on *data literacy,* the term is defined as the ability of gathering, managing, evaluating and using data in applied contexts, through critical lens (Ridsdale et al., 2015). This skill can emerge in specific contexts both at an academic level (manipulation of data for academic communication purposes); and at a professional level, when data is used to inform processes and decisions (more essential) or to generate products and services (advanced level of innovation). The different existing definitions coincide on the following key elements of *data literacy*: extraction, management and processing, ethical and critical approach to data handling. According to a literature review by Maybee and Zilinski (2015), on the basis of the analysis of 8 frameworks for data literacy, the following elements can be identified: (a) Awareness: Understanding data and its role in society; (b) Access: Understanding how to identify, locate and appropriately use datasets and databases (i.e. a collection of structured data); (c) Engagement: Evaluate, analyse, organize and interpret existing data. Make decisions based on data; (d) Management: Plan and manage data, including organization and analysis, security protocols for data storage, sharing data, and data-driven documentation; (e) Communication: Synthesize, create visualizations and data representation; (f) Ethical Use: Identify diversified data sources, in particular data from human and social activity, considering the risks of managing such data. Understand the issues implicit in the use of data; (g) Preservation: Be aware of long-term practices of storing, using and reusing data.

In line with the above mentioned research, the very recent European debate on the Digital Competence, with the framework DigComp 2.1. (Carretero, Vuorikari, & Punie, 2017) has focused data literacy. The concept of Digital Competence, already present in the prior framework of Key Competences for Lifelong Learning from 2006 (European Commission, 2007), recalls the importance of the skills to live in a digital era. However, while the first framework (2006), as well as the framework DigComp 2.0 never included the idea of skills to handle data, the latest version of 2017 (2.1) introduces the component of "data literacy" together with the information literacy dimension.

ISBN 978-615-5511-23-3

Data Literacy within formal learning contexts

Having analysed briefly the debate on the existing frameworks to assess data literacy, let me introduce the universe of educational practices aimed at teaching and learning this complex ability. Within basic K-12 and Higher Education the panorama appears fragmented. While it is clear the central role played by math and statistics, mediated by technological tools, today the reflection is going towards the need of analysing phenomena, understanding their chaotic nature, and hence build/use the necessary to make the disorder to become structured data. Moreover, data can be placed into *narratives,* taking care of their aesthetics in visual representations and critically understanding the socially constructed nature of data. It is worth mentioning that in the US, for the K12 the NGSS – Next Generation Science Standards, 2013, cited in Bowen and Bartley, (2014) – points out the importance of public science, open inquiry and crowd science, as it is presented in the case of Gould (2017). This last author proposes the case of *participatory sensing,* based on the concept of "Internet of Things" (IoT); in this case the students were invited to analyse the data collected by terminals that collect environmental information. The schools (30 classes) collaborated with the University of Los Angeles (Department of Computer Science, Department of Statistics, and the Graduate School of Education and Information Sciences). While undertaking these activities, the students were learning about citizen science, the importance of responsible research as well as rudiments of data science. The students interacted with data through the own mobile devices and shared the data to understand environmental issues, like garbage recycling. The data collected was transformed in numerical and categorical variables, as well as open text. To the data collected the students applied types of analysis like descriptive and inferential statistics, as well as CART, (classification and regression trees), as the simplest models to apply, to understand data transformation and analysis. In this experience the effort was put on leading the students to see how data emerges from collaborative, citizen science approaches; the data treatment was based on constructions that interest the same engaged groups, through procedures that are mostly post-hoc. In this sense, data literacy lying behind the experience went well beyond the mathematical and statistical skills necessary to read and process data. The skills required started with data collection and ended with *data storytelling;* the ultimate goal was to show the complex socio-cultural nature behind every information constructed and communicated through data. In this same vein, Muligan attempted to reflect on the basis for data literacy in primary education (Mulligan, 2015). Another interesting, integrated case for primary and secondary instruction is that of Urban Data Games, led by the Department of Math, Informatics and Technology at the Open University of UK (Wolff, Kortuem, & Cavero, 2015). In this project the aim was to develop the competences to live in "Smart Cities", as living environments to be read and interpreted. The assumptions in this project were the following: engaging students in data handling, within an authentic socio-cultural context of action (the Smart City they live in), through a gamified learning approach, push the students to use math, statistics and informatics in integrated ways. According to the authors, the students were able of achieving not only significant information which enacted them as engaged citizens; they were also practicing skills that align with the national standards in STEM (http://www.nationalnumeracy.org.uk). Wilkerson and Laina (2017) instead analysed the cognitive processes relating interactive

ISBN 978-615-5511-23-3

visualizations of data in kids aged 12-13. When these students were exposed to geographical and ecological information, the expected cognitive processes were: (a) formulation of hypotheses or recovery of hypotheses formulated in considering past activities with non-interactive graphs; (b) mathematical ideas (trend, distribution, quantitative inference, measures of central tendency or dispersion, etc.); (c) focus on the graphic aspects of representation (axes, labels, position, colour form and other visual properties of the data represented which indicate aspects to be interpreted); (d) focus on textual aspects (captions, narrative text surrounding a graph); (e) questioning the reliability and the origin of the data (if the data were collected reliably, questions on sampling, reflection on the collection context or sample characteristics); (f) Local / global tensions (similarities between "local" specific data and generalizations towards universal behaviours); (g) Interpretative report with personal experiences of the student. While the initial cognitive processes (a to d) were more frequent, the students showed some difficulty in passing to the deeper and critical forms of cognitive interaction with graphs. Once again, in this study it is possible to observe the complex nature of data literacy, and the need to integrate more technical skills (in math and statistics) with holistic and situated forms of cognition based on data.

In Higher Education, the situation is similar, and data literacy is claimed to become an important issue within academic skills. Frequently, data literacy is associated with information literacy, becoming a matter of librarians. For example, Carlson, Fosmire, Miller, and Nelson (2011), at the Purdue University, pointed out the importance of skills to conduct e-research tasks. According to the authors' position, digital data coming out from open science could be adopted by students in inquiry processes within formal learning activities. However, it emerged the need to train these specific academic skills. The topics for this type of training should come from the cycle of scientific information: searching and retrieving scientific information (and hence knowing Boolean operators, metadata, scientific databases and open datasets portals); appropriate data management (privacy issues, storage and back-ups); data cleaning and data elaboration within the limits of a scientific discipline; file formats allowing basic and advanced statistical operations not only by the same student but also by communities of unknown users (data sharing); data visualization and reporting. The authors concluded that these abilities imply, among other skills, a good knowledge of economic, legal, social and ethical aspects surrounding the core of math, statistic and digital competences. In a sectorial study, Stephenson and Schifter Caravello (2007), concluded that the development of abilities inherent to data literacy require cross-disciplinary approaches. For these authors, the operationalization of constructs in science encompass form of information transformation from textual and conceptual to mathematical and statistical reasoning, but the awareness of these pathways of transformation are crucial to speak of data literacy. The above considered background oriented hence the learning design I will introduce in the following paragraph, including the educational aims and hypothesis to build *data literacy* in university students coming from the disciplinary field of Education.

ISBN 978-615-5511-23-3

Method

Case study

The present paper is based on a case study, a method that encompass careful analysis of events and narratives regarding a specific subject of study tightly connected to contextual conditions (Yin, 2009). In fact, the case hereby introduced regards the adoption of Open Data as resources for learning, within a specific context of higher education: the course "Learning Design in Adults' Education", devoted to students of the 3rd year of the Degree of Educational Sciences at the University of Florence (6 ECTS, First Bologna Cycle). Eighteen students (11 Female and 7 Male) took part at the experimental learning activity. It is important to mention that the Degree's curriculum offers little opportunities to the students to achieve statistical skills and to analyse quantitative data. Likewise, the professional profile is focused on competences relating the educational relationship and educational activities on the field. The interest on learning design and other processes supporting the documentation of pedagogical practices is emerging and being discussed, but there are no cross-curriculum activities. The course was a special occasion for students to understand the learning design concepts and techniques to apply them in adults' education. Moreover, the course was based on an exploratory learning architecture, which main method was a *project-based learning*. In detail, along each learning module the students were supposed to apply their knowledge, in teams, on the following integrated assignments: "A1) Identifying an adults' educational problem and establishing the learning needs; A2) Macro-design (overall project's aims, goals, learning and evaluation strategies – high granularity level); A3) Micro-design (session-by-session specific goals, learning activities and assessment activities – low granularity level); A4) Implementing and Evaluating the designed educational interventions". The activity relating the use of Open Data was placed as the 2nd learning unit within the Module of Learning Needs' Analysis (A1). This learning unit covered several instruments to explore socio-cultural contexts where an educational project aimed at adults as target, is to be developed. The aim of the specific learning unit on Open Data was to understand how this type of resource can help the educator in analysing the adults' learning needs. In fact, Open Data can be considered an important resource to understand scenarios of intervention, from the international to the local context. Moreover, it could be used as part of educational interventions aimed at civic participation. The educator can explore Open Data analysing learning scenarios and methods of intervention in connection to an educational problem; as well as the recognition of the policy making context and documentation. Open Data could bring key information about learners' situation and needs beyond the general policy reports. Table 1 introduces the micro-phases of the learning unit, which was implemented in along two sessions of two hours (4h total). During the first session, the 1st phase was covered completely, and the 2nd phase was launched. During the second session, the 2nd phase was accomplished and the 3rd was launched and concluded. The first phase consisted mainly in presenting the concept of Open Data and self-evaluating data literacy. The second phase was aimed at exploring data in a sort of "data expedition" (the term was coined by The Open Data Institute – https://theodi.org). The third phase focused the reflection on the experiences as well as the presentations (including tables and graphics) made by the students. Along the phases, the data was collected through the structured self-evaluation form, and by audio-taping the

ISBN 978-615-5511-23-3

sessions' interactions. Moreover, the teacher adopted a digital notebook where several observations and impressions along the two sessions were collected. In the case of the 2nd session, the notes were mainly based on the students' interactions with the Open visualizations and datasets, as a sort of *user-experience.* As for the Self Evaluation form as instrument to collect information on the self-perceived data literacy, it consisted of a rubric with four types of ability and five ordinal levels of mastery. The four types of ability were: Data searching and retrieving (going from finding reports integrated with statistics to searching complex files as datasets); data extraction, in the sense of getting the data as raw material that can be directly handled or that requires processing and polishing in order to prepare it for specific types of analysis; data collaboration, as the ability to arrange data (in local or through the cloud) and manage collaborative processes of data analysis; and data storytelling, as the ability to introduce data effectively in narrative texts to carry out specific messages. The five levels were: no competence, basic, intermediate, advanced and highly advanced. However, as in most self-evaluation tools, the students were provided with specific statements of what being "highly advanced" or "not having competence at all" meant (cfr. Self-Evaluation Form at https://goo.gl/forms/3uQWz5lJfARndz1S2). At every level, the required knowledge on instruments to handle data as well as the creative abilities to generate visualizations and to communicate through data were explained. Moreover, the levels were concomitant with data literacy frameworks: the highest level could be associated to a technical profile or a professional profile adopting daily data in several ways, and the lowest levels (basic) introduced very basic abilities taught within compulsory education. In addition, there were open questions asking "how did you achieve this ability/knowledge" to contextualize the self-perceived ability and control bias in self-evaluation. The rubric ended with a final question on the interest towards further training, which indicated specifically the topics and tools. Again, the fields spanned from "no interest at all" to "want to achieve advanced knowledge and instruments".

Table 1: Learning Unit on Open Data – Phases, Resources and Activities

Phase	Resources	Activities
1- Self Evaluation	Presentation & Instructions https://goo.gl/9pkofu Self-Evaluation Form https://goo.gl/forms/3uQWz5lJfARndz1S2	1.1-Data Literacy Self Evaluation 1.2-Discussion: How data literate I am? How data literate I should be as educator?
2- Data Expedition	PIAAC – OCSE Open Data Instructions & Access: https://goo.gl/1FWYFo	2.1-Exploring PIAAC Open Data visualizations 2.2-Exploring PIAAC Raw Open Datasets
3- Open Data for educators' professionalism	Presentation guidelines https://goo.gl/aahccT	3.1-Presenting the data selected in the context of learning needs' analysis 3.2-Reflecting on the value of Open Data for educators' professionalism

ISBN 978-615-5511-23-3

Results

In this section the results of the learning activities are presented according to the data collected along the three learning unit's micro-phases. The first micro-phase yielded information relating the participants self-evaluated skills, as well as some interesting reflections on Open Data within the educator' baggage of knowledge and skills. As for the self-evaluated skills, the data collected was synthesized through descriptive statistics which are presented in the Figure 1. It appears that the students declared themselves generally at the level of no competence, or basic competence. Moreover, most students connected their knowledge and skills with the first phase of data literacy, namely, *data search*, with 6/18 at basic level and 7/18 at intermediate level; also only in this level 3 students acknowledged an *advanced* competence. It emerges that the poorest skill is *data extraction*, where most students perceive no competence (15/18). For data collaboration and data storytelling, the situation is analogous: half of the students consider to have no competence (9 and 8/18 respectively) or basic competence (7 and 9/18 respectively). We conclude from this briefly depicted situation that the students feel unskilled to deal with data and that they are able of performing very basic operations, mostly connected to a culture of reading printed reports with statistics, with rather static visualizations and tables (data search that lead to *packaged* scientific communication or policy reports). This information was confirmed by open questions in the form. However, the students expressed a rather shy interest in training. To the question which is your interest in learning about data and Open Data, only one student replied to be willing to learn on "advanced instruments"; 16/18 expressed interest on "basic instruments" and 1 was "not interested at all". This situation could encompass a belief that data activities are far from the students' professional identity in construction.

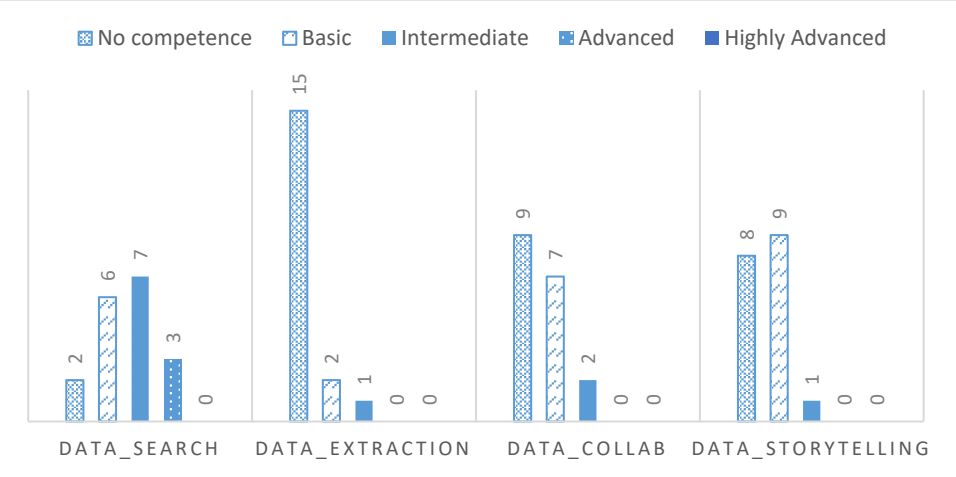

Figure 1. Students' self-evaluation of their data literacy skills

After self-evaluation, it followed a discussion based on the questions: How data literate I am? How data literate I should be as educator? The students pointed out that:

- They felt surprised about the several levels of knowledge required to deal with data.
- They felt generally unprepared to deal with data.
- While a group of students were eager to understand more on open data and to become more data literate, another discussed that this is necessary up to a certain point, as

ISBN 978-615-5511-23-3

educators, since they did not see advanced phases of data analysis as connected with the core of skills required for their professionalism.

Regarding the second phase, Table 2 introduces the main issues yielded after the *user-experience* within the PIAAC open data sites. It was possible to observe that the experience of interacting with data was a hard task to accomplish. While at the end of the activity most students acknowledged the relevance of open data in society, the groups that faced more issues in analysing and using data consider that there is always need of "mediation", that is, experts working in the field of statistics that arrange data for "final consumption". However, half of the class was enthusiastic about the potential of Open Data in society, and for them as educators. Not surprisingly, these students were those able of extracting personalized graphs and to generate their own data tables.

Table 2: Students' user-experience within the PIAAC open data site

Activity: Data expedition	Positive experience	Negative experience
2.1- Exploring PIAAC Open Data visualizations	- Most students liked the possibility of adjusting graphs as they selected skills and countries. - Half of the class was able of extracting visualizations useful to support their claims on adults' education needs.	- One group (5) got frustrated for the data was "superficial" and the type of visualization did not encompass freedom to interact with data in search of what they needed really. - Most students required teacher support to understand the concept of "dynamic visualization"
2.2- Exploring PIAAC Raw Open Datasets	- Two groups were able of creating new tables extracted from raw data (.csv) - The students understood the concept of open data and how they could enable the user to generate original representations.	- Most students felt the task was difficult and required support to operate with the raw datasets. - Two groups only "looked at data" but were unable of editing raw data and generate new representations.

As for the 3rd phase, it was interesting to see the students' commitment to understand the several representations selected according to every specific project. Four educational problems were proposed by the four groups: two of them relating adult learning in elder life; and the other two regarding adults' education for inclusion. The four projects adopted the open data collected as part of the analysis of adults' basic skills that should be considered as part of adults' education in the above mentioned cases. Particularly, they handled variables as sex, age, country and life skills (literacy, numeracy and digital skills, in social and working contexts). Ordering the students' reflections throughout the macro, meso and micro dimensions of learning in the digital landscape, the picture obtained was interesting.

As for the *Macro-dimension*, including the structures and access to Open Data as Open Educational Resources, it should be considered that Open Data portals are still "messy" and mining data requires careful attention and expertise in order to obtain relevant results. Moreover, the generalist nature of OD portals attempts against the very specific needs of data

ISBN 978-615-5511-23-3

search by the educators while writing and application or exploring a social context to elaborate an educational project. As for the *Meso-dimension*, relating learning design, OD require several tools to introduce them successfully to the learners, according to the expected levels of data literacy. These instruments can go from the teacher presentations and exemplar cases, to worksheets and guided practice in interacting with OD portals. With regard to the *Micro-dimension,* that includes the impact of OD on data literacy, training educators to understand the available data, and to mine open data portals, should be considered as part of the basic competences to design educational interventions, as well as to document them. In fact, an important discussion about the data handled by adults in several life situations emerged. While one group pointed out that refined data portals are still far away the literacies of many of the adults they encountered in educational accompaniments, with adults at social risk, another group emphasised the problems arising while handling information where data was present. The exemplar case brought by this group related elders' health care, and the need for them to understand their own data (digital devices for health monitoring) as well as reading minimal data produced by the health care system (epidemiological information). Most educators should accompany elders in continuing learning on these new life skills and they felt unprepared for that situations. As a result, the students' also reflected and acknowledge the importance of their own data literacy to guide others' learning on data and particularly Open Data.

Conclusions

In this paper, I presented a case study on using Open Data for learning in Higher Education. The educational problem I attempted to explore could be connected to the new sets of skills required to participate in a society were not only the digital component, but also the digital data generated and available through several ways are shaping the social fabric. As educational researcher committed with Open Education and interested on new social phenomena emerging in a digital society, my initial motivation was connected to understand whether Open Data can be adopted for learning purposes, triggering forms of reflection and awareness on data-driven processes and hence on own data literacy. However, this type of endeavour led me to focus my research questions in the context of intervention. As teacher at the undergraduate level, I wondered which are the current levels of data literacy in undergraduate students and to which extent data literacy is needed as part of emerging professional profiles. Moreover, as educator committed with training a new generation of educators, my interest went on the direction of discussing with the same students how important Open Data, and the overall data literacy could become for their professionalism. These issues led me to understand the macro-meso-micro structure of the educational problem ahead: while understanding how and if Open Data as available, authentic and rich resources could be placed at the macro-level of learning in digital contexts, the expected outcomes for undergraduate students and the context of higher education; and the specific problem of Open Data for educators, belong to the meso and micro-level. The results in this case study showed that while Open Data offers exceptional opportunities to the society, their only presence may not trigger virtuous practices immediately. At the macro-level, the action taking implies forms of reflection on formal, informal and non-formal learning with Open Data. At the meso-level, it seems that every group and educational

ISBN 978-615-5511-23-3

level, from the whole citizenship and workers, to school and university students require tools to scaffold their experience with Open Data. Therefore, at the micro-level, to promote data literacy it is necessary to design for learning with Open Data, and to search for the appropriate methods to support the students in their journey from no competence or very basic data literacy levels, to more advanced stages. Moreover, it is important for the students (and for all lifelong learners in general) to become aware and to discuss which are their own expectations of data literacy, that is to say, to which extent do they feel necessary to understand data and particularly Open Data. In this regard, more empirical research, beyond the existing frameworks is necessary. The directions for research are doubtlessly connected to action research (more educational experiences systematized and shared), but also to the validation of schemes of educational practice through theoretical reflection or hypothesis testing. Moreover, ethnographies of use could be important to understand the forms of appropriation and the difficulties that hinder it. All in all, a long (but exciting) way to go.

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