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Special Issue

Facets of Data Literacy: advancing the field through interdisciplinary lenses

Guest Editors

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Editorial. Facets of data literacy: Advancing the field through interdisciplinary lenses

Editoriale. Diversi aspetti dell'alfabetizzazione dei dati: i progressi nel campo osservati attraverso lenti interdisciplinari

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Digital data has consolidated as the fuel of technological development. The commercialisation of Large Language Models and Generative Artificial Intelligence has led to a massive adoption of Artificial Intelligence applications by the general public, bringing data literacy to a prominent position in the public debate. In this data-driven economy and society, academia and industry have to collaborate to meet the needs of a data-literate workforce (León et. al., 2020). Moreover, data literacy is also a powerful enabler of civic engagement, as it empowers individuals and communities to keep governments transparent and accountable, tackle local issues, and navigate their own data ecosystems. In this regard, it is also essential support for the wide exploitation of open data and open government resources. Nonetheless, the data-driven practices have led to critical situations, injustice, and concern in several areas of human activity, from the public to the private sector.

The growing availability of data and the increasing incentives to use it, in fact, have brought about a rising concern known as data literacy. This concern is strongly driven by the fact that many individuals lack the necessary skills to effectively utilise the available data, as well as the necessary competencies to make ethical and responsible use of such data. This special issue contains papers supporting this notion, emphasising that data literacy encompasses not only the ability to work with data but also the ability to understand its use and value within different contexts, including areas like citizen science and digital civic engagement.

While there has been an increase in research on data literacy in recent years, much of the existing research is confined to specific disciplinary areas such as research data, and there is still a relative neglect of the civic and citizen context (Yousef, Walker, & León-Urrutia, 2021). Simultaneously, data

has increasingly become a part of citizens' lives through the presence of algorithms, machine learning, and the potential for artificial intelligence. Hence, this special issue has aimed to gather papers that explore the possibilities of comprehensive multidisciplinary research on the societal implications of data literacy, its significance, and how it can be effectively fostered.

In fact, the concept of data literacy, as the educational activity aimed at developing understanding and skills relating to such dimensions of our societies, spots the contextual and diversified nature of data practices in response to or reaction to metrics, quantification, and algorithms. The research on the topic has highlighted the existence of practices of participation linked to data appropriation to express cultural diversity, civic empowerment, and hence social and economic innovation. Instead, another strand of research is particularly focused on uncovering algorithmic bias, unstructured data usage, and the search for data justice. From these diversified strands of research, there emerges a clear need to embrace interdisciplinary discussion and collaboration in order to explore and expand the concept and practice of data literacy. Specifically, teachers and educators at all levels of the schooling system, including higher education and lifelong learning, are called to transform their practice through the introduction of data literacy as a contextualised and complex perspective on an emerging technological revolution in contemporary society.

To this aim, the focus of this special issue was to gather research that deals with data literacy as an emerging topic, and an area of knowledge and practice that requires reflection, discussion and transformative action. To that end, we highlight the relevance of building understanding on the basis of empirical research as a perspective on a complex and emerging social problem. Specifically, we called for contributions referring to research dealing with conceptual competence frameworks or models, applying constructs, and/or catering to practical cases showing the benefits of different data literacy experiences for different target groups across lifelong learning.

We collected four relevant research articles, which bring to the fore the polysemy embedded in the concept of data literacy, as well as the multiplicity of practices it can generate.

Data literacy is not a crucial competence only in Higher education contexts, it is more and more important to promote the introduction of these competences at an earlier stage. In the paper of Havzi, Tonnini, Mauro and Taibi (2023) the importance of developing data literacy in secondary schools has been investigated through the lens of the experiences acquired in the implementation of the two European funded projects. These projects named Data Literate and Dalfys aimed to provide teachers and students with the appropriate tools to face the challenges in introducing data literacy in secondary schools. The two projects analysed how data literacy is perceived by teachers and students, and the results presented highlight the significant interest toward this topic as well as the need of having specific educational intervention and pedagogical models that include data literacy. In these projects the perception of data literacy from the teacher's perspective was also analysed. The results highlighted the need of developing data literacy competences in educators for preparing them to face the challenges of promoting educational activities related to data driven contexts.

In this perspective, Ranieri, Biagini, Cuomo, and Gabbi (2023) delved into data literacy as educators' relevant competence. Their study explores undergraduate educators' perceptions of effectiveness and relevance for a specific module on data literacy. Nevertheless, they move forward from technical perspectives of data, attempting to cultivate a critical-reflective sensitivity towards data among the educators and explore their understanding of statistics within the educational practice. To achieve these goals, they administered a customised questionnaire to 123 educators who actively participated in the training course. The questionnaire served as a tool to gather their insights and opinions. In actuality,

the study's findings showed that the educators highly valued the intervention in terms of its educational content and thematic relevance. However, there were suggestions for improvement in the dimensions of interdisciplinarity and interactivity, indicating potential areas for future enhancement. Regarding the educators' perceptions of data-based knowledge, particularly statistics, a cautious optimism emerged. The findings revealed that there was an openness towards the potential of quantitative data to contribute to understanding reality. It was also evident that the educators did not idealise statistics as the sole source of knowledge, recognising its limitations and the need for a broader perspective. In conclusion, this research study identifies two relevant findings by highlighting the importance of cultivating critical-reflective sensitivity towards data and acknowledging the potential contribution of statistics in educational contexts. The study also underscores the need for further interdisciplinary approaches and enhanced interactivity in similar training initiatives.

Loría-Solano, Guitert, and Raffaghelli (2023) focused on the role of data literacy in promoting citizens' engagement with open data. The researchers conducted a systematic review of existing literature to gain insights into the importance of data literacy and its relationship with the barriers to using open data. The study identified 66 relevant articles through a comprehensive screening process. The researchers employed a keyword mapping technique to analyse these articles and conducted coding and quantitative analysis to extract meaningful findings. Their objective was twofold: first, to understand the role of data literacy among various barriers to using open data; and second, to explore activities related to open data that facilitate informal learning and the development of critical data literacy. The findings of the study revealed that limited data literacy hampers the effective use of open data. However, the researchers also observed that engaging in activities related to open data presents valuable opportunities for citizens to enhance their technical data literacy. This, in turn, enables them to better comprehend and interact with data-driven decision-making processes. Despite the positive aspects, the study highlighted a gap in the literature concerning critical data literacy as a crucial driver for the strategic and transformative use of open government data. The researchers emphasised the need for greater attention to cultivating critical data literacy skills among citizens, as it plays a vital role in leveraging the full potential of open data. Overall, this research study serves as an important foundation for designing lifelong learning interventions that aim to foster open data literacy among individuals, encouraging their active engagement with open data resources.

Lifelong learning and data literacy in adult education are also central in the paper of Zlatkovski, Temjanovski, and Chabukovski (2023). This paper is a position paper, not based on formal research, that proposes a Data Literacy Framework to support the process of bridging the gender gap in Western Balkans among women entrepreneurs. To succeed in today's data-driven economy, women entrepreneurs need data skills and digital skills to unlock opportunities and grow businesses. The focus of any successful business in modern economies is how to equip women with suitable data and digital literacy so they can pursue careers in the digital economy, to contribute to the digital transformation of the economy and the public sector, especially in the Western Balkans developing countries. The proposed Data Literacy Framework should be used as an instrument to devise public policy measures for providing education and training opportunities, design customised data literacy upskilling for women entrepreneurs, implement career guidance services, promote the role of the women in the digital economy, and provide support for more effective deployment of various concepts of the digital society.

The studies in this issue highlight the relevant role data literacy plays in promoting citizens' and educators' engagement in a data-driven environment. Limited data literacy hampers the effective use of data relating to educational contexts. However, these studies also underline that engaging in formal

or informal activities related to data literacy can enhance basic skills. In Havzi et al., authors explore the challenges for increasing the awareness of teachers and students in secondary schools towards the needs of data literacy competences, according with the vision of a new conceptualization of data literacy integrating conceptions, competencies and contexts through a holistic and context-oriented framing of data literacy for researchers and educators (Gebre, 2022). In Loría-Solano et al., informal engagement with open data supports technical data literacy and improves citizens' understanding and interaction with data-driven decision-making processes. These findings are consistent with existing literature in this topic (Santos-Hermosa, Quarati, Loría-Soriano, & Raffaghelli, 2023). Ranieri et al. show how engaging with statistical data makes the educators feel more optimistic about the role of data in their profession while also being cautious about abuses and misuses of data, confirming the findings of previous studies in related fields (Louie, 2022). Zlatkovski et al., move the focus on gender gap with particular respect to women entrepreneurs for what it concerns data and digital skills in general, and a new competence framework on data literacy is needed to reduce the gap of limited digital literacy that constitutes an obstacle for women entrepreneurs in accessing business development (Oggero, Rossi, & Ughetto, 2020).

All studies, though, concur that critical data literacy is an essential driver for the strategic and transformative use of data in different contexts from secondary school to enterprises. Moreover, these studies highlight the importance of interdisciplinary approaches and enhanced interactivity in training initiatives related to data literacy. There is a need for ongoing improvement to ensure that educational interventions effectively address the needs of educators and citizens. Overall, these findings contribute to an understanding of data literacy's importance, the challenges associated with it, and the potential for cultivating critical data literacy skills among both citizens and educators. The studies provide insights that can inform the design of lifelong learning interventions and training programs aimed at enhancing data literacy and promoting active engagement with data knowledge and resources.

In the contemporary era, an interdisciplinary approach becomes imperative, particularly with the surge of recent advancements in Artificial Intelligence that has directed attention toward novel tools and their integration into daily life. However, the embrace of these technologies remains a topic of controversy across various contexts. On one hand, the use of Artificial Intelligence applications is deemed indispensable for managing complex tasks; conversely, it is perceived as a looming threat to human creativity, giving rise to dystopian scenarios where humanity succumbs to machines. Regarding the cultivation of data literacy competences in lifelong learning settings, leveraging recent artificial intelligence-based tools can prove beneficial for both educators and learners. Nevertheless, it is crucial to heighten awareness regarding the limitations and potential pitfalls associated with these technologies, achieved through the implementation of an interdisciplinary competence framework.

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Bringing data literacy competencies in secondary schools

Portare le competenze di data literacy nelle scuole secondarie

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ABSTRACT The importance of developing data literacy skills in secondary schools has been increasingly recognised over the years. In order to achieve the successful development of data literacy skills among secondary school teachers and students, it is necessary to analyse current curricula, implement data literacy projects in school and focus on learning outcomes. It is important to follow the key challenges that teachers and students face in this process. This paper presents the survey results of the piloting study conducted in the framework of Data Literate and Dalfys - two European funded projects that aim at spreading data literacy skills in secondary school contexts. The results show a significant interest of teachers and students to develop data literacy skills but the introduction of data literacy in traditional curricula requires appropriate resources. Temporary solutions, such as introducing data literacy in specific subjects, should be promoted to promptly fill the existing gap in the development of these skills.

KEYWORDS Data Literacy competences; Secondary Schools; European Funded Projects.

SOMMARIO L'importanza di sviluppare competenze di data literacy nelle scuole secondarie è stata sempre più riconosciuta nel corso degli anni. Al fine di sviluppare le competenze di data literacy tra insegnanti e studenti della scuola secondaria, è necessario analizzare i curricula attuali, attuare progetti di data literacy a scuola e focalizzarsi sui risultati dell'apprendimento. Individuare le principali sfide che insegnanti e studenti devono affrontare in questo processo assume un ruolo di primaria importanza. Questo documento presenta i risultati di ricerca dello studio pilota condotto nell'ambito dei progetti Data Literate e Dalfys - due progetti finanziati dall'UE che mirano a promuovere la diffusione delle competenze di data literacy nel contesto della scuola secondaria. I risultati mostrano un notevole interesse degli insegnanti e degli studenti a sviluppare competenze di alfabetizzazione dei dati, ma l'introduzione dell'alfabetizzazione dei dati nei curricula tradizionali richiede risorse adeguate. Dovrebbero essere promosse soluzioni temporanee, come l'introduzione della data literacy in specifiche materie di studio, per colmare tempestivamente il gap esistente nello sviluppo di queste competenze.

PAROLE CHIAVE Competenze di Data Literacy; Scuole Secondarie; Progetti Finanziati dalla Comunità Europea.

1. Introduction

In the last few decades, a rapid advancement in Information and Communication Technologies (ICTs) have influenced significant changes in all aspects of the society. Technological progresses have a significant impact on education and the potential of ICTs in education is still developing. In efforts to improve digital competencies in education, European Commission promoted the Digi-CompEdu framework aimed at building digital competences of educators (Redecker & Punie, 2017). Through the continuous work of the European Commission on the development of digital skills of teachers, the guidelines for teachers and educators on tackling disinformation and promoting digital literacy through education and training were published in 2022, as the key initiative of the Digital Education Action Plan 2021-2027, *“The Guidelines aim to generate a broader understanding of digital literacy achieved through education and training, to promote responsible and safe use of digital technologies, and to foster a better public awareness and knowledge regarding disinformation.”* (European Commission, 2022). All of the above highlights the importance and significance of digital literacy in education.

The usage of technology does not guarantee adequate development of digital competence at a satisfactory level. In this regard, Krumsvik highlights the essential role of teachers in promoting digital competence in students (Krumsvik, 2008), and it is essential to provide teachers with appropriate training for developing their digital literacy skills (Ndukwe & Daniel, 2020). Recent studies showed that educators can develop data literacy during the intensive one-year educations (Kippers, Poortman, Schildkamp, & Visscher, 2018).

Even though research in data literacy is increasing in the recent years (Ghodoosi, West, Li, Torrisi-Steele, & Dey, 2023), the focus on data literacy in secondary schools is underrepresented. This paper aims to introduce the results of two educational projects specifically aimed at spreading data literacy skills in secondary schools. These projects, named Data Literate and Dalfys, have been funded within the European Commission Erasmus+ Programme as Strategic Partnerships. The overall goal of these projects is not only to tackle the specific education challenges brought up by the Covid-19 pandemic (e.g. the implementation of distance learning), but also to address the European Commission’s purpose to consolidate ongoing efforts and further develop the European Education Area, thus improving digital competences, facilitating international cooperation between education institutions, while promoting opportunities for teachers’ continuous professional development. These projects were carried out by a consortium of partners with different expertise and know-how in strategic fields related to the data literacy domain. The Data Literate consortium, led by Vilnius University, includes two companies specialized in digital and data training initiatives (INOVA+ and Dataninja), and 4 secondary schools from Lithuania, Portugal, Spain and Italy¹; whereas the Dalfys project, coordinated by the Italian secondary school “ITET Girolamo Caruso”, includes four secondary schools, one training center, one research center and two SMEs with expertise in educational programmes from Lithuania, Poland, Germany, Italy, Romania and Turkey².

Both projects share a common definition of the term “data literacy”, namely the ability to *“read, write, critically assess, and communicate data in context, including an understanding of data sources*

¹ Please refer to Data Literate website for further information about the consortium, accessed January 23, 2023, <https://www.dataliterateproject.eu/partners/>

² Please refer to DALFYS website for further information about the consortium, accessed January 23, 2023, <https://www.dalfysproject.eu/consortium-en/>

*and constructs, analytical methods and techniques applied — and the ability to describe the use case, application and resulting value*³.

In order to properly assess the outcomes of the pilot phases conducted in the projects, two surveys were designed for detecting teachers' and students' perception on data literacy competences. The surveys have been sent by e-mail to the teachers of the schools involved in the two projects, subsequently they shared the questionnaire amongst students. The answers provided have been analysed and the main insights are summarised in this paper.

The paper is structured as followed: section Background is related to general data literacy concepts and previous work on implementing data literacy learning experiences in secondary schools, in the section Data Literate and Dalafys projects, the two projects are presented, the Methodology section relates to the survey conducted. The results of the analysis of the survey are presented in the Insights and survey analysis section. Final conclusions and future work section summarizes the most relevant insights from the experience conducted.

2. Background

Several authors highlight the importance on giving focus to data literacy within education (Gebre, 2018; Rubin, 2020). Although data literacy is growing and important in building digital competences in education, data literacy education in secondary school context deserves further investigation.

Even though efforts in developing data literacy amongst students are made, Gebre states that the lack of comprehensive definition of what data literacy constitutes an obstacle to implement it in schools (Gebre, 2018). There are two ways of observing data literacy: competency-oriented and empowerment-oriented perspective (Gebre, 2018). Competency-oriented perspective is related to development of data literacy skills – finding, analysing, understanding and interpreting the data, while empowerment-oriented perspective is wider and consists of using data literacy to build equitable and democratic society (Boyd & Crawford, 2012; Gebre, 2018; Wolff, Gooch, Cavero Montaner, Rashid, & Kortuem, 2016).

When researching, developing and implementing data literacy in secondary schools, it is important to look at the development of skills, challenges and strategies from two equally key perspectives - teachers and students.

To ensure development of data literacy competences in students, it is essential to empower teachers with the necessary data literacy competences (Ndukwe & Daniel, 2020). It is important to understand what teacher data literacy refers to their *“ability to effectively engage with data and analytics to make better pedagogical decisions”* (Ndukwe & Daniel, 2020). Ndukwe and Daniel point out a very important dimension of why teachers struggle with understanding teaching dashboards – partly, they lack data literacy skills, but mostly, design of tools does not include teachers as partners (Ndukwe & Daniel, 2020).

It is necessary to give training to teachers for them to be able to effectively use the data, and it is a key prerequisite for them to be able to teach students in the data literacy manner (Mandinach & Gummer, 2016).

Filderman et al. proposed a data literacy training model for the teachers in order to determine the effects of data literacy training on teachers and identified the key concepts of the training to have comprehensive knowledge in data literacy of teachers such as data literacy knowledge and skills, beliefs

³ Definition adapted from Gartner, accessed January 24, 2023, <https://www.gartner.com/smarterwithgartner/a-data-and-analytics-leaders-guide-to-data-literacy>

on data use, the importance of training, sufficient duration of the training and coherence (Filderman, Toste, Didion, & Peng, 2022). In their review, they found that teachers training in data literacy has significant positive effects on teachers' knowledge and skills in general.

Data literacy is highly important for data-based decision making, especially for teachers (Schildkamp, van der Kleij, Heitink, Kippers, & Veldkamp, 2020). It is important for teachers to be able to collect different types of data, to analyse and interpret data, as well as to be able to transform data into information and knowledge, and when looking on teaching data literacy, the list goes even broader. There are theoretical and empirical works that identified different digital skills that teachers should have in order to use new technologies (Touren, Martin, Navarro Asencio, Pradas, & Inigo, 2018; Mei Wei, Yan Piaw, Kannan, & Moulod, 2016), however, those are rarely applied in practice (Rubach & Lazarides, 2021).

Shreiner and Dykes conducted a survey among 262 U.S. elementary and secondary teachers on social studies. They used mixed method analysis to evaluate teachers' practices, beliefs, and knowledge in data literacy (Shreiner & Dykes, 2021). The study was mostly directed towards data visualisation. Even though more than 60% of participants indicated that they "feel" like teaching data visualisations, only 24% of them were constantly positive in their responses to the questions about teaching data literacy. Authors highlight that among these who are regularly teaching data literacy group, 62% were secondary school teachers. Many students are not receiving data literacy instructions, especially from new teachers. Only 11% of the teachers felt confident and efficacious in their ability to help students achieve data literacy skills. The highlight of this study is that 97% of the teachers are underprepared to teach with data visualisations. Most of the teachers do not have knowledge needed to teach data literacy.

In summary, the existing literature shows that teachers have a lack of competence in data literacy, that they have a desire to advance their knowledge in this area, and that trainings have good results in creating data literacy skills in teachers. This is crucial to develop and promote these skills amongst students as well.

Often the intensive use of technology is identified with the development of digital skills amongst students and young population, but this does not mean that they necessarily have data and digital literacy competencies.

As mentioned above, to develop students' digital competences, it is important that their teachers have developed digital competences, as well as adequate knowledge to implement them in subject curricula. Digital competences lead to responsible and meaningful use of technologies.

Research shows that developing students' digital skills can help protect students from inappropriate use of technology and to reduce the risk of gaming addiction amongst children and adolescents (Tso et al., 2022). When observing data literacy skills from students' perspective, the importance of developing these competencies is not questioned, but the importance of emphasising that the use of technology does not necessarily mean the development of digital competencies. Research shows just the opposite - students who use online communication with their friends very often and that those who use social networks a lot, have lower levels of digital competence (Cabezas-González, Casillas-Martín, & García-Valcárcel Muñoz-Repiso, 2021). It is of high importance for educational institutions to implement curricular programs that could strengthen digital competences amongst students from early education.

3. Data literate and Dalfys projects

The project Data Literate and Dalfys aim at promoting data literacy skills development in secondary school contexts. They share the same approach concerning their implementation phases. Specifically, three main stages can be identified: Exploring, Designing and Piloting (Figure 1).

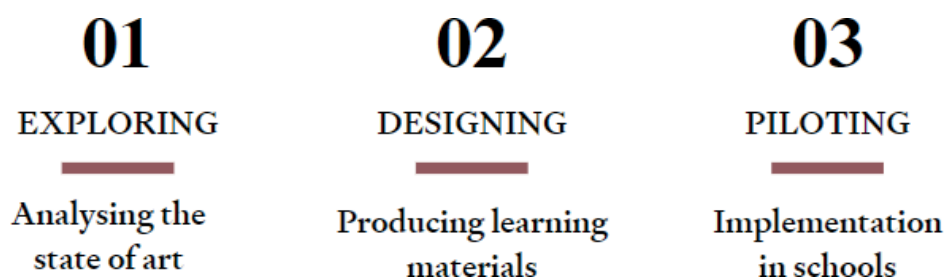


Figure 1. Three main phases of Data Literate and Dalfys projects.

The exploratory phase is dedicated to desk research activities aimed at mapping the “state of the art” of data literacy educational experiences in European secondary schools, highlighting if and how data literacy is included in school curricula. The desk research results are summarised in a report reused in the next steps of the project to specifically address the needs and expectations intercepted. Starting from the information gathered during the research, the designing step is focused on the development of educational content and learning materials to train teachers and students on data literacy topics. In this regard, the lessons designed both for Data Literate and Dalfys - regardless the specificity of each project - can be clustered into the following four main areas, referring to a framework that has at its core the basic competences related with the data workflow:

- **Finding data:** In this module participants will learn what data is and its difference with opinions, which helps at highlighting how data cannot be neutral. Moreover, it will be addressed the importance of fact checking and data verification in order to critically assess data. A specific focus on data sources, format and licences is included.
- **Cleaning data:** Before delving into analytics, it is crucial to understand the key role of the data cleansing process, exploring resources and techniques.
- **Analyzing data:** Elements of statistical literacy are at the core of this module, focused on some tips and tricks to analyse data.
- **Visualizing data:** Understanding data means also understanding how data is visually represented: the basic structure of a data visualisation, what are misleading graphs and how to avoid them, together with the basics of planning a dataviz are the main topics of this module. Eventually a list of different tools for visualising data and to support online classes will be presented.

During the implementation of the Data Literate project’s, teachers have undertaken a training course based on 6 modules. In next phases of the project were dedicated to piloting methodologies and materials which teachers have worked on within their classes.

The pilot phase aims at promoting the development of Digital Data Literacy skills among students, while contributing to teachers’ continuous professional development; overall, four schools successfully joined the pilot phase. Furthermore, each module includes the expected competences to acquire according to the Data Literacy Competence Model (Seymoens, van Audenhove, van den Broeck, & Mariën, 2020) and the proposed learning outcomes.

The educational materials designed in the second step of the project have been used by the teachers of the consortium as a starting point to create their own Learning Unit Plan (LUP). The LUP is the development of content for class-based learning units on data literacy that schools will use during the following piloting step. LUPs are based on a model of transferable learning resources that can be totally integrated in existing learning activities of secondary schools in a modular way. Interestingly, both

in Data Literate and Dalfys the teachers who designed the LUPs do not exclusively teach STEM subjects; this is key to underline interdisciplinarity of data literacy topics.

The LUPs stand for the conceptual backbone for including data literacy in secondary school courses, while promoting innovative study concepts and blended didactic resources for secondary school teachers. The LUPs creation and implementation through the piloting phase are core outputs of the educational projects, thus enabling the introduction of data literacy as a cross-cutting subject for secondary school students and providing not only concrete learning units but also strategies for course organizers.

4. Methodology

In order to properly assess the piloting phase outcomes, two surveys were conducted and answered by teachers and students of the schools who participated in the pilot of both projects. Dalfys participants could access the survey directly from the project's website, whereas for Data Literate project the survey was sent by email to the teachers, who were then responsible for sharing it with students.

The teacher questionnaire intended to evaluate the Learning Unit Plan creation and its implementation through the piloting phase, while the students survey was designed to measure their knowledge and confidence in terms of data literacy skills after the learning sessions. Each questionnaire was divided into two main subsections: "*Part A - General information*" and "*Part B - Evaluation of the piloting sessions*"; in the teacher survey an additional section dedicated to open comments was also included, this section particularly focused on the challenges faced by teachers during the piloting phase.

The questions were structured as multiple choice, Likert scale and - only in few cases - open questions. For example, concerning the evaluation of students' participation during the piloting session, teachers have been asked to rate it on a scale from 1 to 5, where 1 means "*Did not participate at all*" and 5 "*Actively Participated*". On the other hand, students have been asked to rate how much they enjoyed the topics of the learning session about data literacy on a scale from 1 ("Not at all") to 10 ("Totally enjoyed"). An example of multiple-choice question is the one aimed at assessing the usefulness of the educational content to develop the LUP: teachers had to express their agreement with the following statement "*The slides content was useful for the development of the Learning Unit Plan*" and the possible answers were: Totally disagree - Disagree - Agree - Totally agree.

Concerning the students' survey, the section dedicated to the evaluation of the learning sessions on data literacy included 4 open questions about new concepts learnt, the most enjoyable parts of the learning session and main difficulties encountered. For each question there were 100+ different answers, although in many cases the differences did not lie in the answers content, rather in the way they were spelled or written (e.g. How to make graphs - Making Charts). Moreover, many students answered in their mother tongue, so a translation was needed. In order to derive meaningful insights for the piloting overview report many answers have been clustered, e.g.:

- Finding your own data online → Data collection
- Diagrams, tables, different maps → Data visualisation

Focusing on the piloting phase of both projects, which took place in the second half of 2022, the partners involved were 7 schools (Agrupamento de Escolas Sebastião da Gama, Escola Virolai, ITET G. Caruso, Liceul Tehnologic Costache Conachi, Siauliu Didzdvario Gimnazija, Vilnius Jesuit High School, TED Bursa College) and the training center DC Edukacija. Generally speaking, the piloting phase aims at promoting the development of Digital Data Literacy skills among students, while contributing to teachers' continuous professional development.

5. Results and Discussion

Starting from the analysis of the surveys responses, the present section aims at giving an overview of the piloting phase’s results in three main areas: 1) The creation of the Learning Unit Plan and the evaluation of the educational content; 2) The evaluation of the Learning sessions; 3) The challenges faced during the piloting phase.

Before delving into these aspects, it is worthy to give some general information about the sample, to better contextualize the results.

The teacher questionnaires gathered 33 responses; Concerning the teachers’ years of professional experience, 87,5% of respondents had more than 10 years of teaching experience and the remaining 12,5% had between 6 and 10 years. The 3 main subjects taught by teachers who answered the survey are: English (25% of respondents), Computer Science (25% of respondents), Mathematics (19% of respondents). Other subjects are: Chemistry, Commerce, Electronics and Physics.

Overall, 744 students were involved in the pilot sessions, in particular: 215 from Agrupamento de Escolas Sebastião da Gama (Portugal); 102 from ITET G. Caruso (Italy); 315 from Escola Virolai (Spain); 112 from Vilnius Jesuit High School (Lithuania). The surveys addressed to students collected 465 answers in total: 248 from the Dalfys project and 217 from the Data Literate one. However, in the latter case, the number of students reached with the LUPs is higher because not every student who joined the pilot answered the survey. Overall, the piloting sessions had a quite gender-balanced participation in both projects, namely: 52,69% male, 44,09% female, 3,23% other. Regarding the age of participants, the large majority (nearly 70%) of students were 15-17 years old (figure 2).

Generally speaking, all the learning modules (Data Literacy, Understanding your data, Educational Data, Learning and Teaching analytics, Explore data literacy resources already available) have been presented to the students during the pilot, though with different shades (figure 3).

Every school presented more than one module to the students as shown in figure 4. The numbers indicate how many times a single module has been implemented in each school.

The final module of the teacher training course was dedicated to the design of a Digital Data Literacy plan for the students, in order to effectively integrate the use of digital technologies in learning

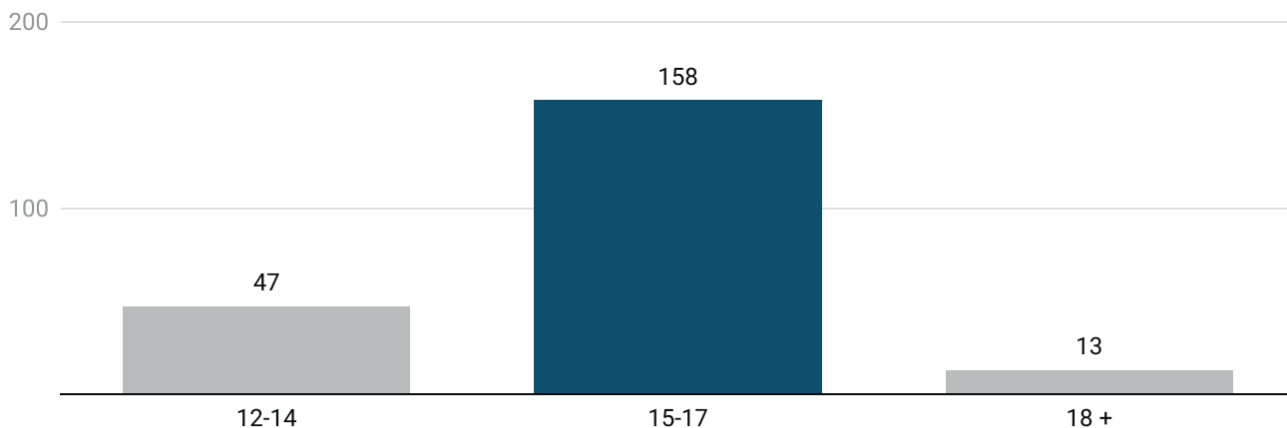


Chart: Datatinja for Data Literate project • Source: Students Piloting survey • Created with Datawrapper

Figure 2. Age groups of the students that participated in the survey.

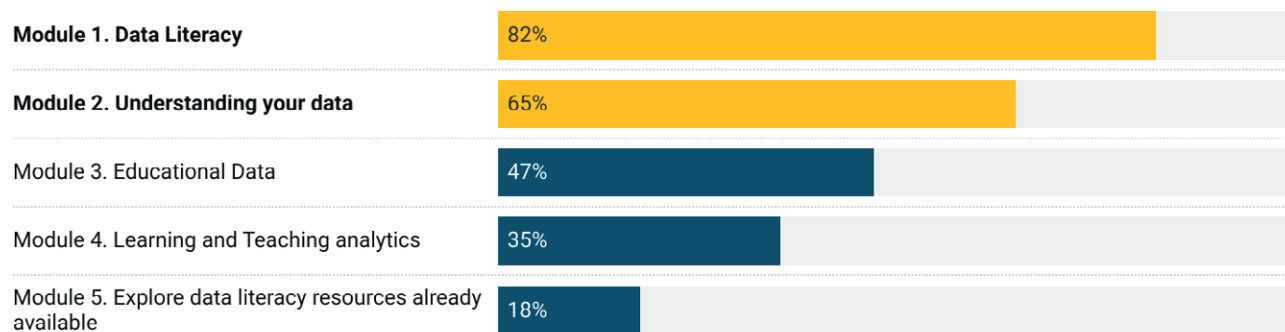


Grafico: Dataninja for Data Literate Project • Fonte: Survey conducted among teachers • Creato con Datawrapper

Figure 3. Presented modules to students during the piloting session.

Module Name	AESG- Agrupamento de Escolas Sebastião da Gama	Escola Virolai	ITET G. Caruso	Vilnius Jesuit High School
Module 1. Data Literacy	1	4	5	4
Module 2. Understanding your data	1	3	5	2
Module 3. Educational Data	2	2	3	1
Module 4. Learning and Teaching analytics	0	3	2	1
Module 5. Explore data literacy resources already available	0	1	2	0

Table: Dataninja for Data Literate project • Source: Teachers Piloting Survey • Created with Datawrapper

Figure 4. An overview of modules implemented in the pilot session by schools.

activities while facilitating students' understanding of working with data. During the piloting phase, almost 80% of the respondents implemented 2 Digital Data Literacy plans in their classrooms, which brings to 29 the total number of Digital Data Literacy Plans developed in the 4 school partners. Moreover, it is worthy to underline that some teachers implemented 1 Digital Data Literacy plan but in different classes, thus reaching a wide number of students.

5.1. Survey analysis

As explained above, teachers piloted in their classrooms the LUPs developed on the basis of the educational content about data literacy provided within the framework of both projects. Therefore, they have been asked to evaluate the learning content suitability for students aged 15-18 on a scale from 1 to 5; on this matter the results are positive, since over 80% of respondents answered either 4 or 5.

Moreover, as an example of multiple-choice question, they had to express their agreement with the following statement "The slide content was useful for the development of the Learning Unit Plan". Evaluating the usefulness of the educational content for the development of the LUPs the respondents unanimously agreed (37,5% totally agree, 62,5% agree). Therefore, all modules of the educational con-

tent (that can be clustered into the 4 core skills of data literacy: finding-cleaning-analysing-visualising data) have been used for the creation of the LUP. Concerning the evaluation of the educational content, students' feedback was also collected: 66% rated the difficulty of the LUP as "Average", 27,3% answered either "Easy" or "Very Easy" and only 6,7% either "Hard" or "Very Hard.

Regarding the evaluation of the learning session, both teachers and students' surveys aimed at investigating the extent to which students actively participated during the pilot session and their satisfaction. The feedback on these aspects is overall positive: on average, the students' level of participation and satisfaction has been rated 8,15/10. Furthermore, a noteworthy satisfaction level of students (82% of respondents) is also detected concerning the methodology used in the pilot session.

Other key insights are the one related to the measurement of the learning outcomes of the piloting session. The results for the two projects are here presented separately. Dalfys project's survey gives interesting insight about students' previous knowledge on Data literacy topics, which they should rate from 1 to 5: On average, students rated their previous knowledge 2,8/5. Thanks to the clustering process described in the previous paragraph, it was also possible to quantify the percentage of students who learnt new concepts and skills after the learning sessions. Indeed, the students stated that thanks to the LUP they learnt new skills (82,2%) and new concepts (89,5%).

On the other hand, Data Literate survey allows us to gather some qualitative insights useful to deeper contextualize what the term "new concepts" means. When asked both about data Literacy theme(s) they have been working on during the learning session and new concepts learned, it is interesting to note that students' answers can be clustered into two main groups: general concept(s) related to the content of the training (e.g. data collection, cleaning, analysis and/or visualisation), and more specific topic related to the project within they applied this knowledge (e.g. solar energy, mental health and covid-19, teens' shopping habits).

To conclude the survey analysis, it is worthy to focus both on the challenges faced by students and teachers during the piloting phase and on future perspectives. As far as the piloting session's challenging moments are concerned, the respondents highlighted 3 main areas:

- Challenges related to the educational content (e.g. no familiarity with spreadsheet, difficulty in finding the right dataset).
- Challenges related to students' attitude (e.g. lack of attention and/or interest).
- Challenges related to time management. Overall, many comments underline that there was not enough time to make students fully grasp all the concepts and to use data effectively for their learning. It is interesting to highlight the following suggestion given in the additional comment: "I would recommend dedicating a full elective subject to data training and more practical activities".

Eventually the survey results highlighted some potential future perspectives of the Learning Unit Plans piloted in several classrooms. Teachers had to rate from 1 to 5:

- The inclusion of the LUP within the curriculum of the class in which the pilot has been implemented (average rating: 4,2).
- The LUP implementation in other classes (average rating: 4,1).
- The possibility to use some content of the LUP of another partner of the consortium (average rating: 4,1).

Concerning the students of the Dalfys project, 231 students out of 247 think that data literacy should be implemented in schools and 212 would be interested in participating in similar activities in the future. While 86,98% of Data Literate students believe that data literacy should be implemented in schools.

6. Conclusions

This paper aimed to give an overview of the pilot phase outcomes of the EU funded project Data Literate and Dalphys, based on the analysis of the surveys designed for teachers and students.

Results of the survey show the importance of promoting data literacy skills is widely acknowledged, both from the teachers' point of view and from students' one. In this regard, initiatives such as the Data Literate and Dalphys projects play an important role and the satisfaction level with the pilot phase is overall positive. Nevertheless, it is key to treasure the feedback collected for future implementation of similar piloting sessions, in particular: improve time allocation (lack of time emerged as a main challenge from teachers' surveys) and increase practical examples in the learning content.

Furthermore, the answers provided highlight a general positive evaluation of the effect of the Data literate project implementation on the institution. Namely, respondents have underlined how it helped to develop a different approach to data, thus acknowledging its impact and potential in improving some practices in schools. Moreover, respondents highlight how the piloting sessions were very useful as a starting point for a discussion on the need to implement a comprehensive Digital Data Literacy Strategy in the whole School. However, in order to launch the process of elaborating such a strategy, promoting more inclusion of teachers and leaders will play a key role.

Since data literacy was not given adequate attention in the classroom curriculum, many comments related to no time to fully grasp all the concepts and to use data effectively for their learning resulted in the idea that there should be one full subject on data training. This could ensure that the gap in data literacy competences is filled faster as well as to better catch up with the time lost in teaching/learning these skills. Certainly, until there are key changes in school curriculum and integration of the data literacy, projects like Data Literate and Dalphys ensure the satisfaction of teachers and students, raise their level of awareness and importance of knowing data literacy, and as the results have shown - improve their skills.

From the survey presented in this paper, we addressed some key challenges that could be useful when implementing similar solutions in schools, as well as the strong will of the teachers and students to teach and learn about data literacy. The understanding of the importance of data literacy in schools is high by teachers and students, which is the key foundation for the successful implementation of data literacy oriented courses.

In future work, longitudinal studies should be conducted that would show how over time teachers and students adapt to studying in a data literacy manner, as well as how "long-term" the effects of such projects are, that is, whether there are significant changes in teaching over the years.

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‘At the tip of data...’: Developing data literacy in educators’ professional development

“In punta di dati”: Promuovere la data literacy nello sviluppo professionale degli educatori

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ABSTRACT This paper presents the results of a study aimed at exploring the perceptions of effectiveness and relevance of a training course addressed to socio-pedagogical educators, to develop a critical-reflective sensitivity towards data. The study also investigates educators’ perceptions with respect to the nature of statistics and its contribution to educational professionals. The tool used for the study was an ad hoc questionnaire, which was filled in by 123 educators who participated in the course. The results indicate that the intervention was appreciated both from an educational and thematic point of view, even though the dimensions of interdisciplinarity and interactivity could be further improved. As regards the perceptions relating to data-based knowledge, with particular reference to statistics, a feeling of cautious optimism shines through, in which an open vision makes its way towards the contribution of quantitative data, without idealising its role as a univocal source of knowledge of reality.

KEYWORDS Data Literacy; Data Perceptions; Data in Education; Educators; Training Needs.

SOMMARIO Questo articolo presenta i risultati di uno studio realizzato con lo scopo di esplorare le percezioni di efficacia e pertinenza di un percorso formativo indirizzato ad educatori socio-pedagogici, per sviluppare in essi una sensibilità critico-riﬂessiva verso i dati. Lo studio ha anche indagato le percezioni degli educatori rispetto alla natura della statistica e al suo contributo alle professionalità educative. Lo strumento utilizzato per lo studio è stato un questionario appositamente predisposto, compilato da 123 educatori che hanno partecipato al percorso. I risultati indicano che l’intervento è stato apprezzato sia dal punto di vista didattico che tematico, anche se le dimensioni dell’interdisciplinarietà e interattività sono ulteriormente migliorabili. Circa le percezioni relative alle conoscenze data-based, con particolare riferimento alla statistica, traspare un sentimento di cauto ottimismo, in cui si fa strada una visione aperta verso il contributo del dato quantitativo, senza idealizzarne il ruolo come fonte univoca di conoscenza della realtà.

PAROLE CHIAVE Alfabetizzazione ai Dati; Percezioni sui Dati; Dati in Educazione; Educatori; Bisogni Formativi.

1. Introduction

We come from a long tradition that has provided us with a monolithic and dichotomous representation of the epistemological nature of disciplines, through the opposition between scientific culture and humanistic culture, or *hard sciences* and *soft sciences*. The list of formulas could go on, but for some time now the philosophy and sociology of science have been questioning the epistemological assumptions on which this dichotomisation is based, to the point of reaching extreme peaks of epistemological anarchism as the Feyerabendian adage suggests: in science ‘*anything goes*’. Without arriving at such conclusions, the growing complexity of the world in which we live requires more permeable cognitive postures, capable not only of separating but also of connecting, capable of navigating between different knowledge and disciplines following trajectories that are not necessarily linear. This is well explained by Morin, the epistemologist of complexity, in *Les Sept Savoirs nécessaires à l'éducation du futur* (2000, p. 2, *our translation*), when he writes: “The supremacy of a fragmented knowledge in the various disciplines often makes us incapable of making the connection between parts and totality, and must leave room for a way of knowing capable of grasping objects in their contexts, in their complexes, in their wholes”. But in order to train new generations in complexity, the first step is certainly teachers’ and educators’ training. Starting with these premises, this contribution illustrates the outcomes of a research-intervention, carried out within the framework of the Training Course for the Qualification of “Professional Socio-Pedagogical Educator” (60 ECTS) at the University of Florence, academic year 2020-2021, with the aim, on the one hand, of raising educators’ awareness of disciplinary fields and approaches that are often perceived as distant (e.g. statistics, quantitative research, data) and, on the other, of exploring their perceptions on this topic, especially in relation to the contribution that data-based research can offer to their profession. As will become clear from the analytical illustration of the research-education course implemented, the approach to data was proposed in a problematising manner, borrowing from the so-called humanities that critical posture necessary not only for *humanities* but for the *sciences*, more generally.

The work is divided into four main sections: in the first, the theoretical framework is presented, with a focus on the concepts of data, data literacy and data literacy in education; in the second, the context of the research-intervention and the instruments developed for the survey are described; in the third, the results are illustrated and, finally, the fourth discusses the main findings of the intervention.

2. Data, data literacy, educational data literacy

2.1. From data to data literacy

One of the main consequences of the digitisation of our societies is certainly represented by the uncontrollable proliferation of data (Borgman, 2016). Indeed, the process of digital infrastructuring of our informational, cognitive, educational, communicative, recreational, etc. activities is producing an unprecedented phenomenon, namely the generation of huge amounts of data generated by human action within platforms (Van Dijck, 2014). As well known, two expressions are used in the literature to refer to these new phenomena, i.e. *platformisation* and *datafication*. The first, *platformisation*, is defined as “*the penetration of the infrastructures, economic processes, and governmental frameworks of platforms in different economic sectors and spheres of life. [...] we conceive of this process as the reorganisation of cultural practices and imaginations around platforms*” (Poell, Nieborg & van Dijck, 2019, pp. 5-6). As for the second expression, *datafication*, it has been used to refer to that phenomenon through

which digital platforms transform into data, practices and processes that have historically eluded quantification (Van Dijck, 2014; Mejias & Couldry, 2019). This process involves not only demographic and profiling data voluntarily released by users in surveys, but especially behavioural metadata, the collection of which takes place through platform-expanding infrastructures such as apps, plug-ins, active and passive sensors, trackers (Nieborg & Helmond, 2019), devices that are now integrated into everyday technologies such as the smartphone, transforming virtually any occurrence of human interaction into data: assessing, paying, researching, watching, talking, socialising, dating, driving, walking, etc. (Poell, Nieborg & van Dijck, 2019). These data are algorithmically processed and, under certain conditions, are randomly made available to a wide variety of external actors.

With the progressive centrality acquired by the phenomenon of *datafication*, the concept of digital competence has been enriched with a new literacy, that is data literacy (Vuorikari, Kluzer & Punie, 2022), thus expanding the educational lexicon in the area of fundamental knowledge for future citizens. Following Carmi and colleagues (2020), indeed, data literacy is a new skill that is necessary not only for work, personal development and social inclusion, but also to mature citizens' awareness of the cultural, political, social, and economic implications of the progressive datafication of our societies. In this regard, we speak of *data citizenship* to be exercised at three levels: (1) *data thinking*, i.e. reading, collecting and critically understanding data on the part of citizens; (2) *data doing*, i.e. actions that can be undertaken in an active manner, such as requesting the deletion of personal data and using the acquired data in an ethical manner; (3) *data participation*, indicating proactive engagement in forms of civic activism and support for the spread of data literacy. In similar terms, Bhargava and D'Ignazio (2015, p. 1) propose a definition of data literacy as the acquisition of skills not limited to the development of technical-mathematical and statistical competences, including both the ability to read data, to create, interpret and manage them, and a critical level of understanding with reference to the representational nature of data, as it reflects a specific way of looking *at* and talking *about* the world (Borgman, 2016). Finally, with a specific focus on the topic of personal data, Selwyn and Pangrazio (2019) introduced the concept of critical data literacy, to refer to the critical ability to manage personal data, considering the following aspects: identification of data (e.g. understanding the type of data in question, whether voluntarily given or automatically extracted from the system), understanding of data (e.g. how they are handled and processed), data reflexivity (e.g., analysing the implications of personal data reuse), critical use of data (e.g. reading the Terms of Service, managing privacy settings, etc.), and tactical use of data, from the perspective of civic activism.

2.2. Data literacy and educational implications

The subject of reading and understanding data has also progressively entered the educational sphere. In particular, the consistent integration of teaching and learning process management platforms, so-called learning management systems, in the educational system has led to the emergence of new fields of research, such as Educational Data Mining and Learning Analytics. Indeed, education is a field in which the process of data acquisition and the application of analysis techniques, performed by software and algorithms, can find significant feedback in terms of visibility and credibility (Williamson, 2017). However, in order to fully benefit from the data generated within instructional systems and more generally for active citizenship, user interest in the potential of digital tools and skills in data interpretation are key conditions along with clear and effective communication of data on the research side (Wolff et al., 2016). As Raffaghelli (2017) points out, there is an urgent need for educators

and students to understand the opportunity to use data to support educational processes, developing technical skills in understanding, analysing and interpreting data, and gaining awareness of the social and educational implications associated with data collection and aggregation, in the broader perspective of active digital citizenship. In this regard, it is noteworthy that while the focus on data regulation policies is growing, there is not so much emphasis on building skills in the use of data that inform educational practice (Mandinach & Gummer, 2013). There are a number of professional development opportunities for teachers of different school levels, which relate to the skills of processing, assessing and monitoring learning outcomes to support school management (Raffaghelli, 2020). Furthermore, following the review of the literature on education professional development, Henderson and Corry (2021) made some recommendations in relation to data literacy programmes: (1) implement competence-focused programmes, (2) encourage collaborative opportunities for participants, (3) model the use of data from both quantitative and qualitative sources, and (4) investigate the role of technology and big data in data literacy. Another relevant aspect is related to the time and modalities required to develop data literacy, which cannot be acquired through short, extemporaneous training events: long-term collaborative approaches are more likely to lead to the desired results (Ebbeler et al., 2017). With regard to educators specifically, it can be observed how the inequality generated by the indiscriminate application of automated systems and algorithms also affects their work, as they find themselves in contact with some of the most disadvantaged segments of the population. Eubanks (2018), who has systematically investigated the impact of data mining and predictive risk models on the most economically disadvantaged groups in the USA, argues that some systems come to replace the decision-making process of frontline social workers. However, this does not result in adequate training aimed at equipping these professionals with an appropriate knowledge of the dynamics of data and their use.

3. Research context

3.1. *The Course for Educators and the session “At the tip of data...”*

The research-intervention presented here took place, as anticipated, within the framework of the Training Course for the attainment of the Qualification of “Professional Socio-pedagogical Educator” (60 ECTS), launched during the academic year 2018-19, at the University of Florence and aimed at in-service educators (Fabbro et al., 2022; Ranieri et al., 2020; Ranieri & Giampaolo, 2018). The course was divided into six modules focusing on the following topics: relational dynamics in educational contexts (M1); theories of educational events and professional identity (M2); instructional design in social and organisational contexts (M3); analysis of educational needs and impact assessment (M4); facilitation of learning processes (M5); management of educational and training organisations (M6). In terms of methodology, the course was delivered in blended (or mixed) mode and each module was structured in four phases (Ranieri & Giampaolo, 2018), adopting appropriate approaches for adult education (Knowles, Holton & Swanson, 2012): from the initial activation of participants through the presentation of a problem scenario, to individual documentation on the constructs covered through video lectures, to the practical application of the knowledge acquired by means of online exercises, to the final reflection to foster knowledge transfer.

Due to the pandemic, all educational activities have been conducted online with a remodeling of delivery methods. A novelty in comparison with previous years was the enrichment of the training course through a focused session, called “At the tip of data...” and curated by a Sociology lecturer.

More specifically, for each day dedicated to synchronous online training, in place of the face-to-face events, there was a 1-hour training session, during which the lecturer showed data and statistics on specific topics of interest to the professional profile of the educator, commented on them and then discussed them with the trainees. There were seven events in total and they obviously also focused on the impact of Covid-19, since the activities took place in the middle of the pandemic period. The following table (Table 1) provides some detailed information on the events held, with references not only to time and theme but also to the source of data used.

As can be seen, the different topics intertwine with each other, reflecting the extent of the economic, social and psychological distress generated by the Covid-19 pandemic through a data-based narrative that took the shape of *data storytelling* (Ojo & Heravi, 2018), a narrative technique that combines the use of data, images and words, transforming data analysis into a comprehensible storyline for a wider audience.

Table 1. Features of the 'At the tip of data...' heading.

N.	Date	Title	Theme(s)	Data sources presented
1	21/11/2020	At the tip of data. Education and care in the time of the pandemic.	<ul style="list-style-type: none"> - Traditional, new and future poverty - Educational poverty - Third Sector and Socially Responsible Business - Perceptions, moods and values by age 	<ul style="list-style-type: none"> - ISTAT2020 - CARITAS2020 Report - Save the Children 2020 - With Children/Openpolis 2020 - PoieinLab Social Research 2020
2	19/12/2020	At the tip of data. Life will come back and will have other eyes: old, young, adults after the pandemic.	<ul style="list-style-type: none"> - Social representations of life stages - Regulatory guidelines 	<ul style="list-style-type: none"> - PoieinLab Social Research 2020
3	23/01/2021	At the tip of data. The Day After of social and educational policies: the Italian, German and English systems compared.	<ul style="list-style-type: none"> - Welfare systems compared: Italy, Germany, England - Social expenditure on GDP and per capita 	<ul style="list-style-type: none"> - EUROSTAT, PML database - PoieinLab Social Research
4	20/02/2022	At the tip of data. Socio-educational work at the time of Covid-19.	<ul style="list-style-type: none"> - Remodelling of educational projects - Role of technologies - Educators' visions of change 	<ul style="list-style-type: none"> - Empirical study on convenience sample (Gaggioli, Gabbi, Ranieri, 2021)
5	20/03/2022	At the tip of data. Children of a lesser god: who loses (and who wins) in labour markets at the time of Covid-19.	<ul style="list-style-type: none"> - The labour market - Returning Poverty 	<ul style="list-style-type: none"> - ML, ISTAT, INPS, INAIL, ANPAL (2021)
6	24/04/2021	At the tip of data. Between Starry Heaven and Moral Law: Schooling, education and cultural change at the time of the pandemic. An investigation by PoieinLab.	<ul style="list-style-type: none"> - Remote Education, quality of education 	<ul style="list-style-type: none"> - PoieinLab Social Research 2020
7	08/05/2021	At the tip of data. Love in the time of cholera: friendship, romantic relationships, changing sexuality.	<ul style="list-style-type: none"> - Demography, natural balance - Marriages and civil unions - States of mind, friendship, affectivity 	<ul style="list-style-type: none"> - ISTAT 2021 - PoieinLab 2021

3.2. Objectives of the study and research questions

The study presented here aims to explore the perceptions of effectiveness and relevance of a training course oriented to the development of a critical-reflexive sensitivity towards data by social-pedagogical educators. It also aims to investigate the views of educators, in their different roles, with regard to the nature of hard science, namely statistics, and the contribution they can make to educational professionalism. The research questions (RQ) that the study sought to answer can be summarised as follows:

- RQ1. Whether and to what extent the training course was perceived as didactically effective and content-relevant?
- RQ2. What is the perception of educators with respect to hard sciences, with particular reference to statistics and data-based knowledge?

3.3. Data collection and analysis procedures

To answer the research questions, an ad-hoc questionnaire was constructed, which was first drafted by one researcher and then validated through discussion and analysis with two other researchers. The questionnaire was administered together with the final satisfaction questionnaire in the 2020-21 edition of the course. It included both open and closed questions with the dual purpose of surveying the course participants' enjoyment and investigating what the audience's perceptions of the usefulness, in a broad sense, of statistics were. In particular, beyond a section devoted to socio-demographic data, the questions examined, that were dedicated to the training session "At the tip of data", focused on the general degree of satisfaction with the themes of the session (a question consisting of 8 closed-ended items), going then into detail on perceptions relating to the themes of statistics and quantitative research and asking the learners to express their perceptions on them (a question consisting of 8 closed-ended items).

The answers to these questions were broken down according to a 10-value Likert scale from the minimum level 1 ("Not at all") to the maximum level 10 ("Completely") of agreement with the proposed statement. The questionnaire was administered online between June and July 2021 via the Moodle platform of the University of Florence, where students were registered for course attendance. Data analysis was carried out with the support of the R statistical software. A descriptive statistical analysis was conducted for the closed-ended questions; see section four for details of the results.

3.4. Participants

The questionnaire was administered to a convenience sample, therefore neither probabilistic nor representative of the reference population, consisting of participants in the last edition of the course, i.e., educators working in the socio-pedagogical field. 123 educators (M=40, F=83) aged between 25 and 58 (average age= 41.3 years; SD 6.43) and with a prevalent length of service of between 10 and 15 years answered the questionnaire.

With regard to the level of education, over 48.78% have an upper-secondary-school diploma, 14.63% have a Bachelor's degree, 12.20% have a five-year degree and 16.26% a Master's degree, finally, a small minority 7.32% have completed a postgraduate school and one participant (0.81%) also holds a doctorate degree.

The areas of intervention are mainly in the school sector with 21.21% of the participants and in the disability support sector in 18.61% of the cases. In addition to these, the areas of youth problems (10.82%), marginality and social exclusion (11.26%), reception and integration (9.09%), social welfare

(4.76%) and social-health (7.79%), and parenting and family (3.46%) are also represented to a lesser extent. The remaining 17.40% is divided into other categories with percentages of less than 3%.

With regard to professional experience in education and social work, the largest number of participants have between 10 and 20 years of experience (48%) and 36% have worked in the sector for between 3 and 10 years, while 16% have more than 20 years of experience.

Finally, with regard to the professional roles they hold, 17.07% hold managerial roles such as Manager or Area Coordinator, while 78.04% hold operational roles such as Educator, Animator or Basic Assistant, 5% answered 'Other', with no further specifications.

4. Results

4.1. Whether and to what extent the training course was perceived as didactically effective and content-relevant? (RQ1)

In response to the question "How personally satisfied are you – on a scale of 1 (not at all) to 10 (completely) – with the following aspects?", a very high degree of general satisfaction was predominantly noted, as shown in Table 2 below, where 70% of the respondents expressed a satisfaction value of 7 out of 10 or higher.

In particular, it can be seen that the most appreciated aspects were the clarity of the presentation, both from the point of view of the speaker (M=6.94; S.D.=3.18) and of the commentary material produced for the presentation (M=6.89; S.D.=2.81), while a lower agreement can be noted in relation to the relevance of the various themes dealt with in the training session with the specific professional field of socio-pedagogical educators (M=6.39; S.D.=3.29). It should also be noted that there is a high response variation within the same items, made visible by the rather high values of the standard deviation index. In fact, the higher the standard deviation, the higher the variation in the data, indicating that most of the data are not clustered around the average, but that the participants even expressed

Table 2. Perceptions regarding the relevance of the themes covered.

Item	M	D.S.	Median	7	8	9	10	Tot.	N/A
Timeliness of the themes	6.76	3.74	9	10 8%	11 9%	17 14%	45 38%	118	5
Relevance of themes to the work of educators	6.39	3.29	8	11 9%	23 19%	19 16%	22 19%	118	5
Relevance of selected data to the phenomenon discussed	6.67	2.96	7	13 11%	15 13%	27 23%	18 15%	118	5
Clarity of graphic representations (figures and tables)	6.60	3.01	7	24 21%	22 19%	18 15%	18 15%	117	6
Clarity of commentary captions	6.89	2.81	8	19 16%	24 20%	23 19%	17 14%	118	5
Clarity of presentation of the speaker	6.94	3.18	8	9 8%	14 12%	31 26%	27 23%	118	5
Speaker's ability to engage learners	6.58	3.17	7	15 13%	18 16%	23 20%	20 17%	115	8
Level and quality of the discussion	6.59	3.09	8	20 17%	27 23%	16 14%	19 16%	116	7

Table 3. Perceptions of teaching effectiveness.

	Number of occurrences	Percentage (of respondents)
General feedback		
The way the training session was organised was fine	45	38.6%
Evaluation of the organisational aspects		
I would have reduced the time: one hour is too long	11	8.9%
I would have spent more time on it: an hour is short	13	10.6%
Evaluation of the teaching content		
Less space for data presentation, more space for discussion	31	25.2%
I would also have included insights from qualitative data (research based on focus groups, life stories, in-depth interviews, etc.).	29	23.6%
A more interdisciplinary approach would have been appropriate (sociology, anthropology, psychology, pedagogy, history, economics, etc.).	31	25.2%

conflicting opinions. An example of this is the perception of timeliness of the themes outlined where, although it averaged a positive value ($M=6.76$; $S.D.=3.74$), 38% of the participants chose the value of highest satisfaction (10), while 15% expressed the opposite value of lowest agreement (1).

The learners were asked a further multiple-choice question, “If it were up to you, how would you have organised the rubric?”, concerning satisfaction with the training session on both organisational and content aspects. The results, which are shown in Table 3, confirm the general satisfaction with the set-up given, although we can see a widespread demand for more in-depth thematic analysis, discussion opportunities and interdisciplinary approaches.

In fact, 38.6% of the respondents appreciated the general structure of the training session, without considering any particular changes necessary, although the interactive moments of the lesson were appreciated, which for 25.2% of the participants would have deserved greater emphasis. Another interesting answer was the agreement on the interdisciplinary approach to be emphasised more than what was provided (25.2%) and the proposal to expand the topics with presentations and explanations of qualitative research (23.6%), thus taking into account subjective and interpretative elements, as well as statistical-descriptive or inferential ones.

4.2. What is the perception of educators with respect to hard sciences, with particular reference to statistics and data-based knowledge? (RQ2)

With regard to the theme of educators’ perceptions of quantitative research and statistical data, the following question was asked: “Based on your own ideas and experience, how much do you personally agree – on a scale of 1 (not at all) to 10 (completely) – with each of the following statements concerning quantitative research and statistical data?”. Table 4 below shows the participants’ perceptions in relation to the second research question expressed as agreement with the following statements:

- A. “In the end, statistics are always misleading: if I have eaten a chicken and you haven’t, based on statistics, we have eaten on average half each”.
- B. “Numbers in themselves are not very useful: what is important is to understand more deeply the motivations of those involved in the phenomena than those that describe them quantitatively”.

- C. "Statistics are useful because they make it possible to understand the dimensions of phenomena and this is the first step towards finding the underlying reasons".
- D. "True science is made up of numbers and mathematical calculations: any other information is too much at risk of bias and subjective interpretation".
- E. "Quantitative research and statistical data are only useful if they dialogue with qualitative research and more introspective information, and vice versa".
- F. "A number, when interpreted in the light of others, stimulates the imagination and also arouses emotions that are essential for learning and the desire to learn more".
- G. "Knowing the quantitative dimensions of phenomena is essential not only for one's work but also for understanding the world in which we live and developing informed opinions".
- H. "The objectivity of statistics is an illusion: numbers can always be processed to prove one's beliefs".

Table 4. Perceptions of hard sciences and quantitative measurements of phenomena.

Statement	M	D.S.	Median	1	2	3	4	5	6	7	8	9	10	TOT.	N/A
A	4.21	2.67	5	22 18%	14 12%	12 10%	7 6%	25 21%	16 13%	8 7%	9 8%	1 1%	5 4%	119	4
B	4.64	3.09	4	16 14%	18 15%	8 7%	14 12%	13 11%	9 8%	13 11%	8 7%	9 8%	9 8%	117	6
C	6.90	3.13	8	6 5%	2 2%	3 3%	5 4%	7 6%	11 9%	15 13%	21 18%	17 15%	29 25%	116	7
D	3.87	2.73	4	19 17%	19 17%	13 11%	13 11%	16 14%	13 11%	6 5%	10 9%	4 3%	2 2%	115	8
E	6.79	3.40	8	5 4%	3 3%	6 5%	3 3%	4 4%	7 6%	18 16%	20 18%	14 12%	33 29%	113	10
F	5.88	3.02	7	7 6%	5 4%	8 7%	8 7%	13 11%	13 11%	20 17%	16 14%	14 12%	12 10%	116	7
G	6.49	3.29	7	2 2%	5 4%	3 3%	5 4%	11 10%	15 13%	10 9%	16 14%	25 22%	20 18%	112	11
H	3.85	2,85	3	19 17%	21 18%	15 13%	12 10%	13 11%	15 13%	3 3%	9 8%	1 1%	7 6%	115	8

From these values, we can see that no clear agreement, or disagreement, emerges with the proposed statements, which, in fact, constitute contrasting opinions on and attitudes to the disciplines pertaining to hard sciences and data-based knowledge, particularly with reference to the elements of numerical-statistical measurement and evaluation. In general, the statements concerning more cautious and optimistic attitudes in relation to statistics (C, E, F, G) were those that met with good agreement among the participants. In contrast, the more extreme statements either in favour (D) or against (A, B, H) quantitative approaches received less agreement. However, even in the case of this question we can observe a high degree of variability among the answers, which are widely distributed over the whole range of agreement provided.

The statements that are most perceived as 'true' are C (M=6.90; S.D.=3.13), E (M=6.69; S.D.=3.40) and G (M=6.49; S.D.=3.29), from which it emerges that the quantitative (statistical) dimensions are essential for understanding the phenomena and for a critical approach to one's profession (C, G), but also that these numerical dimensions are only useful, when integrated with a qualitative approach and

Table 5. Comparison on values from 1 to 5, of the agreement between operational roles and management to the proposed statements.

Statement	Mean for workers (N=96)	Mean for leaders (N=21)	General mean (N=123)
A. Statistics are ultimately always misleading [...].	4.4	3.1	4.2
B. Numbers in themselves are not very useful [...].	4.7	3.6	4.6
C. Statistics are useful [...]	6.8	6.9	6.9
D. True science is about numbers and mathematical calculations [...].	3.7	3.9	3.8
E. Quantitative research and statistical data are only useful if they dialogue [...].	6.5	7.7	6.7
F. The number, when interpreted in the light of others, stimulates the imagination [...].	5.8	5.3	5.8
G. Knowing the quantitative dimensions of phenomena is essential [...].	6.7	5.8	6.4
H. The objectivity of statistics is an illusion [...].	4	2.9	3.8

with more introspective information (E). On the contrary, statements D ($M=3.87$; $S.D.=2.73$) and H ($M=3.85$; $S.D.=2.85$) were considered to be ‘falsar’. It is thus observed that the educators do not express a perception of science linked purely to numerical values (D), but that they, nevertheless, consider these measurements to be characterised by a high degree of objectivity (H).

Finally, for purely descriptive purposes, we calculated the average agreement with the proposed statements by distinguishing between managerial (i.e. Managers, Coordinators) and operational (i.e. Educators, Animators, Base Assistants) roles, the values of which are shown in Table 5.

Although we are aware that the low sample size (particularly with regard to management roles) does not allow for a systematic evaluation of these results, there is nevertheless substantial agreement between the values in the two professional role categories. It is interesting to observe how, where the deviation is larger, in particular for statements A, B and H, the management roles show greater trust in statistics and research based on quantitative methodologies, disagreeing more on the items concerning the deceptiveness and illusory nature of statistics and the uselessness of numbers (per se), than the operational roles. On these items, management roles expressed themselves more strongly than statements, as well as in relation to the necessary dialogue between qualitative and quantitative research for an appropriate understanding of phenomena (E). In addition, the response to question G, where operational roles expressed greater agreement with the statement that knowledge of the quantitative dimensions of phenomena is essential for one’s work and understanding of the world, than managerial roles did, is in contrast.

5. Discussion

This research aimed to investigate perceptions of the effectiveness and relevance of the “At the tip of data” training session, which was carried out in order to develop socio-pedagogical educators’ critical-reflexive sensitivity towards data and explore their views of the nature of statistics and the contribution it can give to educational professionalism. Through the administration of a questionnaire on the evaluation/satisfaction of the initiative (ex-post), the aim was to investigate the extent to which the training session was perceived as didactically effective and content-relevant and what the educators’ perceptions of hard sciences, with particular reference to statistics and data-based knowledge, were.

In general, the teaching approach and, to a large extent, also the proposed topics were appreciated by the participants, emphasising not only the relevance and clarity of the contents, but also the qualities of interdisciplinarity and interactivity to be further refined. More space, in fact, is required for discussion, an essential ingredient of adult education for better negotiation and personalisation of content (Knowles, Holton & Swanson, 2012), and greater openness to qualitative-interpretive aspects that appear fundamental for contextualising data in relation to social, cultural and educational phenomena.

Turning to the perception of the hard sciences by educators, a picture emerges of cautious optimism, without incurring in excessive devaluation of quantitative data, but neither in its opposite idealisation as the sole reference for knowledge of reality. Measurements and statistical processing are considered useful above all because they make it possible to understand the dimension of phenomena, as a first step to direct the subsequent search for causes and possible interpretations. The difference in role, whether operational or coordinating, can highlight different perspectives from the point of view of the professional relevance of quantitative information that educators encounter in their daily lives. Educators in close contact with beneficiaries' report, in fact, a greater degree of agreement with the need to also know the quantitative dimension of phenomena in order to improve their professional practice, probably to integrate the more subjective view that prevails in the individual or small group relationships they manage. On the other hand, management roles also show a clear agreement with the need to integrate the two perspectives, in relation to their commitment to monitor, design and coordinate interventions.

This generally positive response with regard to the use of data-based knowledge in the educational professions seems to indicate an evolution of the conceptions typically associated with the figures of the socio-pedagogical educator and the coordinator of socio-pedagogical services (with reference to the managerial roles that emerged from the questionnaire): it is well known how the centrality of the relationship for the exercise of these professions has sometimes led to opposing the educator's profession to "numbers" or "technologies", both cold entities when compared to the warmth of social ties and human relationships (Ranieri, 2020). There is no doubt that, on a pedagogical level, the relationship is and remains an essential condition for the construction of an effective educational path. Nevertheless, as we have already pointed out, the responses of educators and managers reveal interesting perspectives on the role of quantitative knowledge in their professional practice. Such perspectives need to be nurtured and supported through targeted training interventions with the aim of enabling these figures, who often operate in disadvantaged social contexts, to master cognitive dimensions that would risk being removed from the control of human intelligence, becoming the exclusive prerogative of automated decision-making systems (Eubanks, 2018; Raffaghelli, 2020).

6. Conclusions

Humanistic culture and scientific culture have long been pitted against each other in the Western tradition. This opposition is reflected in the educational paths of old and new generations as well as in the way the professions themselves are conceived. Yet, in a world increasingly dominated by algorithms, continuing to propose a disconnected vision of knowledge risks compromising our possibility of a profound understanding of phenomena. Indeed, through the flatness of our social living, actions and interactions give rise to a proliferation of data that, if, on the one hand, elude human control – either due to a lack of awareness of the new digital grammars (Selwyn & Pangrazio, 2019) or due to objective cognitive differences in terms of processing capacity – on the other hand, represent the raw material of algorithmically governed profiling mechanisms (Poell, Nieborg

& van Dijck, 2019; Van Dijck, 2014). Such mechanisms affect not only the world of consumption, but also that of education in its different articulations, from formal contexts such as school and university, to the non-formal contexts where social educators typically operate. Nevertheless, in the training of educational professionals, the topic of data and the educational implications associated with it still remains largely absent (Mandinach & Gummer, 2013). The study presented in this contribution shows how, when appropriately anchored to the professional interests of educators, the topic generates attention. In particular, the request made by the participants to give the training intervention a more markedly dialogic slant reveals a view of data in which the interpretative element defines its meaning. Data not as facts to be observed, but as representations to be discussed (Borgman, 2016). At the same time, it confirms how collaborative approaches can be more effective (Ebbeler et al., 2017), albeit according to different declinations in relation to the specific professional function. This critical-reflexive sensitivity, in fact, is accompanied by a perception of the hard sciences, in particular statistics, as a form of data-based knowledge that can provide useful elements for educators as a complement to their knowledge of the particular situations with which they are confronted on a daily basis, and for the coordinators of educational services as a basis for more effective planning. That said, it should be emphasised that, given the characteristics of the sample, these conclusions cannot be universally generalised. More studies in this direction are needed to further investigate the topic and to foster the development of appropriate conditions for the implementation of effective educational data literacy paths (Raffaghelli, 2017, 2020).

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(Open) Data literacy: Which relationships with open data adoption? A systematic review of the literature

Alfabetizzazione ai dati (aperti): quali sono i legami con un uso efficace dei dati aperti? Una revisione sistematica della letteratura

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ABSTRACT Data literacy is considered a key dimension supporting citizens' enhancement of open data. Nevertheless, more precise definitions of its role and the consideration of nuances between the types of knowledge and abilities that influence a relevant use of open data are needed. Therefore, we carried out a systematic review of the literature, spotting: a) the role of data literacy among several barriers to use; and b) activities around open data that promote informal learning by supporting the development of critical data literacy as a proxy of the citizens' further engagement with open data. We screened and selected 66 articles, applying a keyword mapping technique, followed by coding and quantitative analysis of the articles. Our findings highlight that, on the one hand, limited data literacy interferes with the use of open data. On the other hand, open data activities appear to generate relevant opportunities for cultivating citizens' technical data literacy, allowing them to understand and interact with data-driven decision-making processes. Nevertheless, there is little attention on critical data literacy as a key driver for the strategic and transformative use of open government data. Finally, this study could set the basis to support lifelong learning interventions aimed at cultivating open data literacy.

KEYWORDS Open Government Data; Open Data Use; Informal Learning; Critical Data Literacy; Open Data Literacy.

SOMMARIO L'alfabetizzazione ai dati è stata evidenziata come una dimensione chiave a sostegno della valorizzazione dei dati aperti da parte dei cittadini. Tuttavia, si rende necessario approfondire la ricerca per fornire definizioni più precise sui i tipi di conoscenze e competenze che influenzano l'uso pertinente dei dati aperti. Abbiamo quindi condotto una revisione sistematica della letteratura, per mappare: a) il ruolo dell'alfabetizzazione ai dati tra le varie barriere all'uso dei dati aperti; e b) le attività intorno ai dati aperti che promuovono l'apprendimento informale sostenendo lo sviluppo dell'alfabetizzazione critica dei dati come indicatore del successivo impegno dei cittadini con i dati aperti. A tal fine, abbiamo esaminato e selezionato 66 articoli, applicando una tecnica di mappatura delle parole chiave, seguita dalla codifica e dall'analisi quantitativa degli articoli. I nostri risultati mostrano che, da un lato, una bassa alfabetizzazione dei dati interferisce con l'uso dei dati aperti. D'altra parte, osserviamo che le attività sui dati aperti sembrano generare opportunità rilevanti per coltivare l'alfabetizzazione tecnica dei cittadini

sui dati, per consentire loro di comprendere e interagire con i processi decisionali basati sui dati. Tuttavia, viene prestata poca attenzione all'alfabetizzazione critica dei dati come fattore chiave per un uso strategico e trasformativo dei dati pubblici aperti. Infine, questo studio potrebbe gettare le basi per sostenere interventi di apprendimento permanente volti a coltivare l'alfabetizzazione ai dati aperti.

PAROLE CHIAVE Dati Aperti di Governo; Uso dei Dati Aperti; Apprendimento Informale; Alfabetizzazione ai Dati Aperti.

1. Introduction

After the initial wave of enthusiasm about open data creation, the attention has gone over its use and reuse, to become relevant open knowledge (Open Data Foundation¹). The literature is indeed concerned about the lack of open data use and reuse techniques (Matheus & Janssen, 2020) as this has major technological, empowering, and civic monitoring consequences for its social potential (Baack, 2015). While various open databases are available, independent of their size, software platform, administrative and territorial scope, most Open Government Data entries are underutilised (Quarati, 2021).

Among the various problems concerning the lack of use, data literacy appears to be relevant. It can be considered a recent, emergent part of information literacy, and it relates to the increasing attention to quantitative information and digital data representations generated within the digital environments adopted in professional and daily life. For instance, Usova and Laws (2021) point out that data literacy plays a relevant role within the overall context of new forms of information literacy. They basically conclude that what emerges from the body of literature is that data literacy becomes an essential competency to contribute to aggregated data, data visualisation, data storytelling, analytics, etc. as new forms of required information literacy. In line with this perspective, the European Digital Competence Framework for Citizens from the EU Commission, former DigComp 2.1 and recently upgraded to version 2.2. focus the relevance of data literacy. The framework distinguishes that at the most advanced and specialised level of this dimension, a citizen can create solutions to solve complex problems with many interacting factors that are related to browsing, searching and filtering data, information, and digital content (Carretero, Vuorikari, & Punie, 2017, version 2.1); and that the citizen must be aware of data collection and usage for algorithmic procedures in many areas of daily life, by both private and public providers (Vuorikari, Kluzer, & Punie, 2022). Moreover, Maybee and Zilinski (2015) consider it reasonable to assume that the development of data literacy may be informed by the scholarly discussion around information literacy. Hence, they refer to data literacy as a set of skills based on accessing, managing, communicating, preserving, and ethically using data to elaborate information within a context. In particular, they specify that data can be considered as a piece of information that needs to be analysed, elaborated, and that can be also integrated into information products, as well as informational outputs like written texts, articles, and social media communication. These authors even include in their model other informational forms such as videos.

The knowledge, attitudes, and skills of citizens to make targeted and effective use of open data for their own lives and socio-cultural contexts appear to be central (Boyчук, Lloyd, & Mackeigan, 2016). Thus, it could be hypothesised that the development of skills to deal with data infrastructures and domain knowledge for their application are elements that allow the citizen and the professional

¹ <https://okfn.org/opendata/>

to make more specific and effective use of data (Gil-Garcia, Gasco-Hernandez, & Pardo, 2020). Nevertheless, technical data literacy would not be the only data required: open government data has been deemed a driver of transparency and transformation upon the basis of a holistic, situated, and critical view of data in their political contexts of production (Baack, 2015). There is a strand of literature covering the role of critical approaches to data advocating for the need of “hacking” open data to promote citizens’ empowerment and the visibility of hidden collectives (Milan & van der Velden, 2016; Pybus, Coté, & Blanke, 2015). However, the connection with the research on data usage appears to be less explored.

Therefore, we carried out a systematic review of the literature whose purpose is exploring the contexts in which the use and learning of open governmental data germinate, identifying the barriers that impede its use and that are deemed requirements for its optimal use, as well as considering the professional learning that emerges. Specifically, our work seeks to focus on the role of data literacy (particularly applied to open data and through a critical lens) in promoting open data usage; and the role of open data in promoting professional learning supporting data literacy.

In this context, we propose the following research questions:

- RQ1 What are the contexts of use and learning based on open data?
- RQ2 What are the barriers to using open data, and within those barriers, what role do technical and critical open data literacy play?
- RQ3 What types of learning are promoted by the use of open government data?

Answering the questions above through a systematic literature review aims to contribute to the scholarly debate generating a springboard for public and educational policy in the sector.

2. Background

The reuse of existing open data is tantamount to the lack of updated items (Degbelo, Wissing, & Kauppinen., 2018); the assumption that data are readily available or easily accessible when they are not (Jarke, 2019); and the low quality of open data (Ruijter, Grimmelhuisen, van den Berg, & Meijer, 2020), which means they cannot be reused due to missing features. For example, metadata deficiency has been highlighted (Quarati & Raffaghelli, 2020b). Attrition between disciplinary sectors employing incompatible nomenclatures and metadata tags has also been noticed (Edwards, Mayernik, Batcheller, Bowker, & Borgman, 2011). Data connectivity again limits data utilisation (Haklae, 2018). Moreover, technology and open data acceptability have also been linked to its utilisation (Zuiderwijk, Janssen, & Dwivedi, 2015). Also, several authors point to a mismatch between users’ demands and expectations and the datasets’ possibilities (Ruijter et al., 2020) and the fact that published data are not relevant to users’ concerns (Bonina & Eaton, 2020).

A cross-cutting factor is represented by the skills and knowledge of citizens and professionals to adopt open data infrastructures. According to Van Veenstra, Grommé and Djafari (2020), for data analytics to be effective in the public sector, it is necessary to cultivate organisational, legal, and ethical competencies within a context of collaboration to guarantee their usage for improved efficiencies and/or operations. And while open data might provide some of the information citizens require, it is not always simple to comprehend, utilise, or collaborate with (Robinson & Johnson, 2016). Adults’ lack of digital competency, as demonstrated by Jarke’s (2019) study, leads to their exclusion from user groups during the creation of civic technology apps. Information technology, in this sense, is a transversal component that can either facilitate or obstruct the adoption of open government (Gil-Garcia, Gas-

co-Hernandez, & Pardo, 2020). The quality of data provision and the adoption and use of open data have been hampered over the past decade due, in large part, to a lack of investment in the development of data literacy, as stated by Davies and colleagues (2019).

However, a relevant problem is to re-centre the definition of data literacy, since the literature reports several perspectives and approaches to the skills, attitudes and knowledge to be considered as part of such a literacy.

Montes and Slater (2019) claim that the lack of a coherent and generally accepted definition of data literacy and requisite skillset leaves us without a real quantification of progress on open data literacy. Data literacy can be considered or should integrate technical and critical perspectives: one view of Data Literacy can be related to the skills required to work with math concepts and basic statistical elaborations. Along with its history connected with numeracy, the term acquired various meanings, including dimensions such as: critical reasoning; communicating, modelling, problem solving, represent numerical information; using the symbolic, technical, and formal language of the mathematical operations and the use of mathematical instruments. Recently, the use of open data can be defined as the competencies, knowledge and skills needed to download, clean, sort, analyse and interpret open data in a specific context (Zuiderwijk, Janssen, & Dwivedi, 2015). Given its relevance, data literacy has become an essential part of digital competence for all citizens as outlined in the DigComp Framework 2.1 (Carretero et al., 2017).

However, there is a clear need for competences development for the effective use of public sector data analytics in organisations (van Veenstra et al., 2020). Kassen (2020) states that the reuse or processing of open data to develop third-party applications and projects requires skilled enthusiasts and tech-savvy citizens who are willing to contribute with their time, knowledge and expertise to the creation or co-creation of products based on open data.

While the aforementioned definitions focus on technical proficiency, another perspective views data as a technological assemblage that is founded on and has an effect on preexisting sociocultural institutions (Sander, 2020). The ability to critically examine data, including its concepts, visualisations, and any operations performed on it that can expose some user groups to unfairness or ethical concerns, is what is meant by a “*critical approach to data*” (Knaus, 2020). Hence, the importance of data transparency, democratic design and control of data infrastructures, and the local ownership of data is emphasised as tools in the battle against inequality. As important is encouraging professionals who utilise data for services or projects to think critically about the inclusion gaps in data and the harm that can result from them (Montes & Slater, 2019, p. 283). This has implications for what is referred to as data justice where Taylor (2017) posits that “*fairness in the way people are made visible, represented and treated as a result of their production of digital data – is necessary to determine ethical paths through a datafying world*”. Also, D’Ignazio and Bhargava (2015) worked on forms of popular education where data is assessed considering the needs of communities from participatory frameworks and socio-cultural reflection. More recently, D’Ignazio and Klein (2020) have developed the concept of “*Data Feminism*” in which they propose a critical instrumental conception, based on intersectional feminism, to review data structures and their consequences on the population.

Several authors contend, there is a need for the integration of both technical abilities with a critical perspective on the socio-political layers behind data infrastructures, labelling, algorithmic procedures etc., to promote people’s empowerment, agency, and ultimately, social justice (Atenas, Havemann, & Timmermann, 2020; Raffaghelli, Manca, Stewart, Prinsloo, & Sangrà, 2020; Matheus & Janssen, 2020).

Reinforcing the crucial idea of assembling both technical and a critical perspective to embrace complexity in data literacy, a relevant strand of research analysing and evaluating interventions for

the development data literacy go in that direction. Some agencies like the Open Data Institute have encouraged the creation of data products, such as business and use cases, using real data, while developing their open data skills, as is the case of the public sector in Malaysia (Mustapa, Hamid, & Md Nasaruddin, 2019). Similarly, the study reported by Koltay (2017) considered the relevance and need to promote an open data literacy approach in researchers and librarians. The opportunity to engage with open data to reflect and to develop critical skills has been discussed in several empirical studies. Raffaghelli (2018) observed how the students performed a critical analysis by identifying limitation of open data portals coupled with the reflection on the importance of data literacy in society, especially in the most vulnerable groups. It was also observed how this debate was transferred by the students to their professional activity as social educators. Other authors have also emphasised the need of adopting open data for learning at all levels (Coughlan, 2019). After an initial survey, Boychuk, Lloyd and Mackeigan (2016) study on citizens' use open data for the full democratic use, posed data literacy skills solutions to higher education students and librarians, and encourage the development of applications or APIs. Finally, a study in Nigeria (Ifeanyi-obi & Ibisio, 2020) explains that the use of open data supports the development of an analytical methodology and a collaborative network in the agricultural sector key to innovation.

The activities aimed at developing the literacies to promote open data usage can take many different facets and forms. For instance, The Open Data Institute works on various data expeditions approaches to learn how to explore datasets, and download and reuse them. Another example is the School of Data², which promotes the philosophy of learning by doing with real data, with Data Expeditions and Data Pipeline being a series of methodological steps. Similarly, the European Open Data Portal³ <https://data.europa.eu/es/training/elearning> has an e-learning module that introduces open data, concepts, success stories, access, and exploitation. Moreover, annually there is the Open Data Day⁴ where groups around the world create local events in which open data is used within their communities to show its benefits and encourage the adoption of OGD public policies, businesses, and civil society. However, according to Khayyat and Bannister (2017), field experiments, such as hackathons and competitions, continue to take place, but there has been no systematic research on the factors that contribute to a vibrant and sustainable co-creation ecosystem with civil communities. Still, there has been a focus on technical and managerial skills, with less emphasis on critical approaches (Raffaghelli et al., 2020).

Thus, our initial literature review supports the hypothesis that critical data literacy is needed to use data more diligently, but it also supports the idea that to critically engage with open data, one needs to be exposed to several digital infrastructures and types of data in situated civic participation spaces.

This literature review addressed our study of data literacy and other hurdles, particularly learning needs and techniques that could lead to lifelong learning policies to promote open data literacy as the integration of technical and critical perspectives in open data consumption.

3. Method

This publication reports transparently on systematic reviews and meta-analyses using the PRISMA methodological procedure (Moher, Liberati, & Tetzlaff, 2009). This strategy controls researcher bias

² <https://schoolofdata.org/methodology/>

³ <https://data.europa.eu/en>

⁴ <https://opendataday.org/>

in data gathering and analysis (Petticrew & Roberts, 2006). It involves analysing, summarising, and reporting a significant amount of unmanageable literature.

This selection was analysed to detect emerging concerns and problems related to the research questions. Papers were classified using thematic analysis (Braun & Clarke, 2006). The writers used the literature review and study objectives to construct a codebook with pertinent themes. Then, the selected articles' text was codified using *ex-ante* themes. As described below, interrater agreement measures confirmed the procedure.

Two phases elaborated extracted data. To answer RQ1, bibliometric maps based on article abstracts, titles, and keywords were employed to understand theme groupings and get first insight into the data.

Subsequently, a descriptive analysis of the articles classified according to the codebook completed the answer to RQ1, and by combining the variables' data in contingency tables, information was obtained to answer RQ2 and RQ3, as well as to clarify findings and conclusions about the problem and research questions.

3.1. Sampling and Data Analysis

For the sampling or selection of the articles under study, the PRISMA method was adopted as detailed below. The PRISMA protocol, (Moher et al. 2009) is widely accepted as a systematic method for prove review. It is applied in studies such as Patterson & Morshed (2021), Sangrà, Raffaghelli and Guitert-Catasús (2019), and as well as with a view of quantitative analysis such as Zawacki-Richter and Latchem (2018). The main PRISMA steps carried out are: 1. Selecting scientific databases, 2. Searching the databases with keywords of interest for several articles, 3. Analysing the selected articles by reading them in their entirety.

Selection of Databases. The literature review used SCOPUS, ISI Web of Science, and DOAJ (see Figure 1). The first two indexed high-quality, restricted-access journals. DOAJ, which promotes open access and connects to full-access materials, was deemed to balance this. These databases covered empirical and social research. Since EditLib and ERIC specialise in teaching and educational technology, their information was removed from the search.

Selection of several articles using keywords. The following keywords, according to the RQs formulated, were searched in the selected databases: Open Data AND Government AND Usage. From the word Usage, only *us** is included to contain words related to usage. The following logical queries to the selected databases were used:

- SCOPUS and DOAJ: (open AND data) AND (government) AND (*us**)
- WOS: (open AND data) AND (government) AND (*usa**)

Then data was filtered by English language, articles, and reviews. A total of 383 articles was obtained from this query. Of these, 25 duplicates were identified. Once eliminated, 358 articles were available for the screening phase. Articles were screened through the process of reading abstracts and through the following exclusion criteria:

- a) Date before 2016;
- b) Absence of DOI;
- c) Other open data topics apart from OGD;
- d) Not an article or review;
- e) Not in English;
- f) Related to OGD but not its use;
- g) Not available.

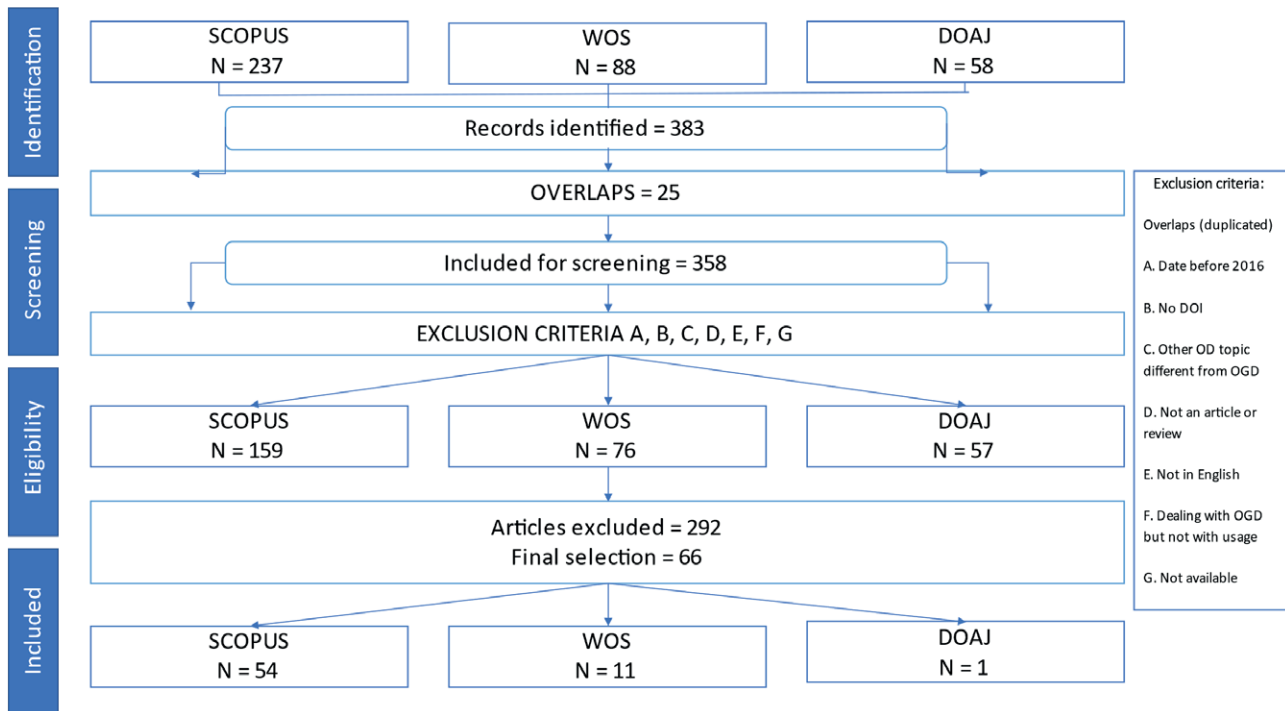


Figure 1. PRISMA diagram.

These exclusion criteria are defined based on the research objectives. After this process, 66 articles were obtained out of 358. Figure 1 illustrates the selection process.

The research of articles spanned the last five years, as general criteria applied to emergent phenomena. Indeed, from our general search only 20% of the papers fall below the 2016, and they focus on information literacy rather than data literacy. Moreover, the texts of the articles without DOI were requested to the authors and by interlibrary loan. A period of three months was considered before discarding the papers unavailable. Nonetheless, after a systematic review of abstracts, the mentioned papers were subsequently excluded because they did not include relevant information in terms of the research aim or because of some other exclusion criteria and numbered lists can be used as follows.

Analysis of the articles by reading them in their entirety. For this phase, a total of 66 articles were obtained: 82% from SCOPUS, 17% from WOS, and 1% from DOAJ.

For the quantitative analysis, the articles were coded and classified into different categories, according to the Codebook defined by the authors. As can be seen, the identified fields attempted to capture:

Identity of the research (Authors, Title, Year, Title of the source, No. of Citations, DOI, Type of Document, Abstract of the article, Keywords of the author).

Type of open data and applications on which the research is focused: Discipline, Type of Open Data, Open Data Applications.

Barriers to the use of open data.

Types of learning generated using open data.

Specifically, the CODEBOOK (Tab. 1) defines each of the fields or variables under study and presents the set of categories defined and then validated, their name, description, categories, type of variable (text, numeric, nominal). A full version of the codebook with text's extracts coded are provided in the open data record (Loría-Solano et al., 2021).

Table 1. CODEBOOK.

Fields	Description	Subfields: Codes assigned/Themes	Type of variable
Authors	Progressive number of Author: 1st, 2nd, ...n	Name and Surname of the Publication's author	Open Text
Title	Publication Title	Title assigned by the authors	Open Text
Year	Year of publication	Number	Numeric, discrete
Source title	Journal, Conference, or other information indicating the type and context of publication	Title/name of the source	Open Text
Cited by	Number of authors citing the publication under analysis	Number	Numeric, discrete
DOI	Digital Object Identifier	Specific DOI	Open Text
Document Type	Type of publication	Article Review Not categorised	Text Labels, Nominal
Abstract	Synthesis of the research as provided by the authors	Abstract found in the article or database	Open Text
Authors Keywords	Specific words describing the content/focus of the research	Keywords	Open Text
Discipline	Connected to the overarching disciplinary field where the research can be placed and based on the keywords given by the authors.	Health Social Sciences Natural and applied Sciences Computer sciences Other	Text Labels, Nominal
Type of Open Data	The conceptual definition and Characterisation of the types of Open Data	OGD ORD POD (Private Open Data)	Text Labels, Nominal
Applications of Open Data	The conceptual definition and Characterisation of Open Government Data, applications, and benefits	Governance Open cities Industrial Innovation Education and training	Text Labels, Nominal
Types of Learning triggered	OGD usage and motivations. How OGD is used. Levels of OGD usage. Areas or topics where it is used.	Civic education Political participation Professional learning Technical Data Literacy Critical Data Literacy not mentioned	Text Labels, Nominal
Issues preventing usage	Issues or characteristics that prevent the usage of Open Data	Technical Data Literacy Critical Data Literacy Quality of data Technology not mentioned All others	Text Labels, Nominal

The definitions and extracts included are considered a sample to exemplify the concepts, due to the restriction of space to comment all the 66 papers selected.

To validate the classifications made in the database of articles generated, there was a double screening by the two authors of the publication. Firstly, one of the authors analysed the whole sample of 66

papers. In parallel, the other author reclassified a 10% of them. Finally, the first author also performed another analysis after six months of working with the database. To measure the consistency and agreement between them, a Cohen's Kappa was performed over the three codification outputs. The result obtained was $k = 0.64$, meaning that there is a substantial agreement between researchers as it is in the range between (0.6 and 0.8). An open data has been produced and published as supplementary material to this article (Loría-Solano et al., 2021).

As a critical appraisal of the research, a discussion of the paper was held in the context of a PhD school, where the selection of papers and initial classification were presented to students and instructors. In addition, the preliminary results were presented and improved through a conference (Loría-Solano & Raffaghelli, 2021).

Data Analysis. The extracted data were elaborated in two phases. As a first phase and to respond to RQ1, a keyword map was created following the bibliometric pattern (van Eck, Waltman, Dekker, & van den Berg, 2010). This type of visual representation is based on graphs consisting of nodes and edges: while the nodes may represent publications, journals, researchers or keywords, the edges represent forms of relationship between the nodes. In the keyword map, co-occurrent terms provide information about the distribution of topics in the abstracts of the articles under study. The visualisation shapes not only explore a current static relationship, but also highlight groups (clusters) that are "closer" within the relationship. VosViewer software was adopted to produce this type of visualisation. We adopted the clustering method to understand possible topics around data usage and the presence of data literacy, as emerging from the textual automated analysis. With respect to the second phase, a descriptive analysis of the data of the articles classified according to the codebook was carried out, which completed the answer to RQ1 and, by combining the data of the variables in contingency tables, information was obtained to answer RQ2 and RQ3 digging deeper on the types of data literacy and the learning opportunities generated from open data.

4. Findings

In the following, we introduce the findings organised as responses to the research questions.

4.1. RQ1 *What are the contexts of use and learning based on open data?*

The list of keywords from the abstracts of the articles under study is presented in Table 2, which specifies the term, the number of occurrences, as well as a term relevance according to the bibliometric keyword map's metrics (cfr. methodological section 3, above, as estimation made in VosViewer). Most relevant terms are presented at the top of the table.

In the top positions, keywords such as dataset, barrier, OGD, governance and public administration, among others, were identified, then the map was plotted. The map of keywords, which projected a first figure on the emerging themes, provided a first level of information about the contexts of research on the creation and use of Open Data.

Figure 2 presents the keyword map, and the clustering of most frequent terms shows their associations, represented in different colors and thickness of the lines; and the most frequent terms are represented by larger nodes.

Figure 2 shows that four groups or clusters are formed, each represented by a distinctive color. The clusters are composed by keywords that describe them and whose size depends on their relevance.

Table 2. Term, occurrences, and relevance of keyword map.

Term	Occurrences	Relevance	Term	Occurrences	Relevance
point	6	2.2	collaboration	6	0.82
world	9	1.91	society	7	0.8
dataset	11	1.87	need	12	0.77
issue	9	1.82	role	9	0.73
OGD	12	1.74	stakeholder	10	0.7
term	8	1.72	perspective	9	0.63
governance	10	1.62	city	10	0.61
public administration	7	1.54	challenge	10	0.57
open data policy	10	1.35	innovation	12	0.54
relationship	8	1.32	resource	14	0.48
open government data	15	1.3	factor	12	0.47
public sector	6	1.29	example	8	0.46
government data	6	1.25	country	16	0.45
opportunity	8	1.2	way	11	0.43
interest	7	1.17	model	14	0.4
data quality	7	1.16	set	14	0.38
order	8	1.14	area	9	0.37
benefit	9	1	access	14	0.35

Table 3 shows the words that constitute each of them and give us an idea of the areas or contexts in which the topics of the articles are developed.

The clusters were studied based on the relationship between the words in the summaries of the articles read. Thus, based on the frequencies and associations evidenced by the analysis, a series of themes per cluster emerged:

Red Cluster. Model and order of public administration with interest in the perspective and role of stakeholders and society for innovation in the public sector.

Green Cluster. Need for open data policy and quality for governance and its relation to the problem of obtaining the expected benefits.

Blue Cluster. Challenge in the way of accessing the type of data as a resource and opportunity for collaboration in the public sector and cities.

Yellow Cluster. Governmental open datasets of national value.

The clusters show contexts of use of the data that would help in the successive reading of the concepts coded and analysed quantitatively. Specifically, it is appreciated 1) the interest of the public sector in considering the perspective of stakeholders and society for social innovation and in public administration; 2) the need for public policy and data quality to obtain the expected benefits such as governance; 3) Access to open government data and how this can be an opportunity for collaboration in cities and with the public sector, for which the required capacities must be in place to be able to do so.

By observing the word map and its relationships, along with the reading of the articles, it can be concluded that government open data is a social resource that should be accessible to all stakeholders via public policy modelling quality data that enables collaboration of various sectors to achieve social innovation, public administration, and governance at both the city and country levels.

The information supplied by the keyword map and quantitative frequencies permits us to provide an initial response to RQ1. What are the uses and learning contexts for open data? Based on the sub-

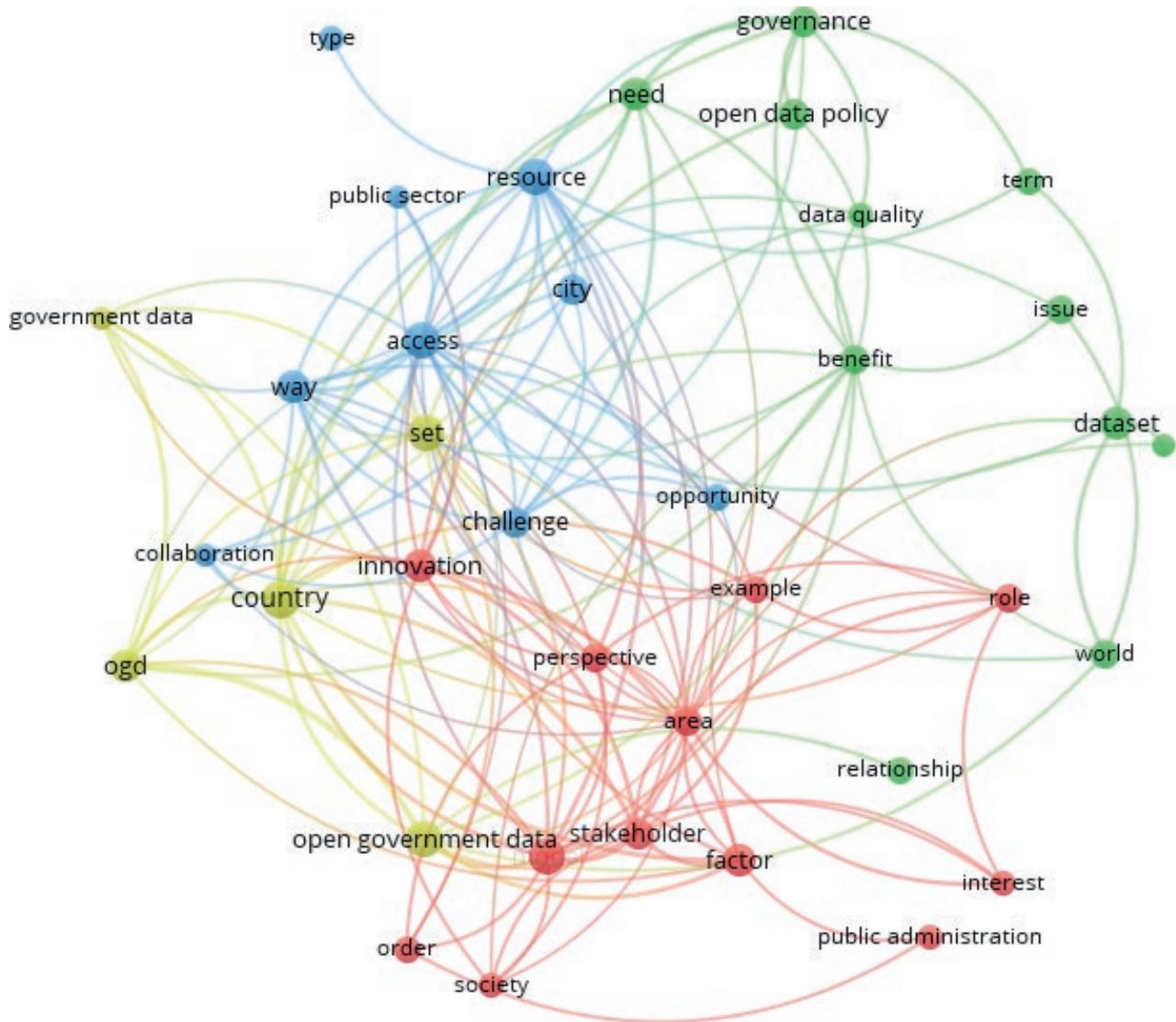


Figure 2. Keyword map (article abstracts).

jects found in the clusters, we hypothesised that the contexts of open data use are both at the city and national levels, where there is a policy of data availability for all stakeholders and where individual and collaborative data use is encouraged. Supporting usage in various circumstances could result in benefits such as innovation at the social level, in public administration, and in governance. The analysis suggests that collaborative access to and use of open data might facilitate innovation, a concept associated with learning processes that generate new knowledge, in this case about OGD. Further study can give information on the forms of learning that may potentially modify the use of open data, thereby characterising the contexts of use more precisely.

In accordance with the interpretation of the green cluster, the keyword map suggests that 41% of the articles under review discuss the use of open data for governance. Thirty percent of the data have innovation as a focus of application, where topics such as the generation of technological platforms and applications for increasing usage by stakeholders are mentioned, such as innovation in the red cluster

Table 3. Clusters identified in the key word map.

Red cluster	Green cluster	Blue cluster	Yellow cluster
area	benefit	access	country
example	data quality	challenge	government data
factor	dataset	city	OGD
innovation	governance	collaboration	open government data
interest	issue	opportunity	set
model	need	public sector	
order	open data literacy	resource	
perspective	point	type	
public administration	relationship	way	
role	term		
society	world		
stakeholder			

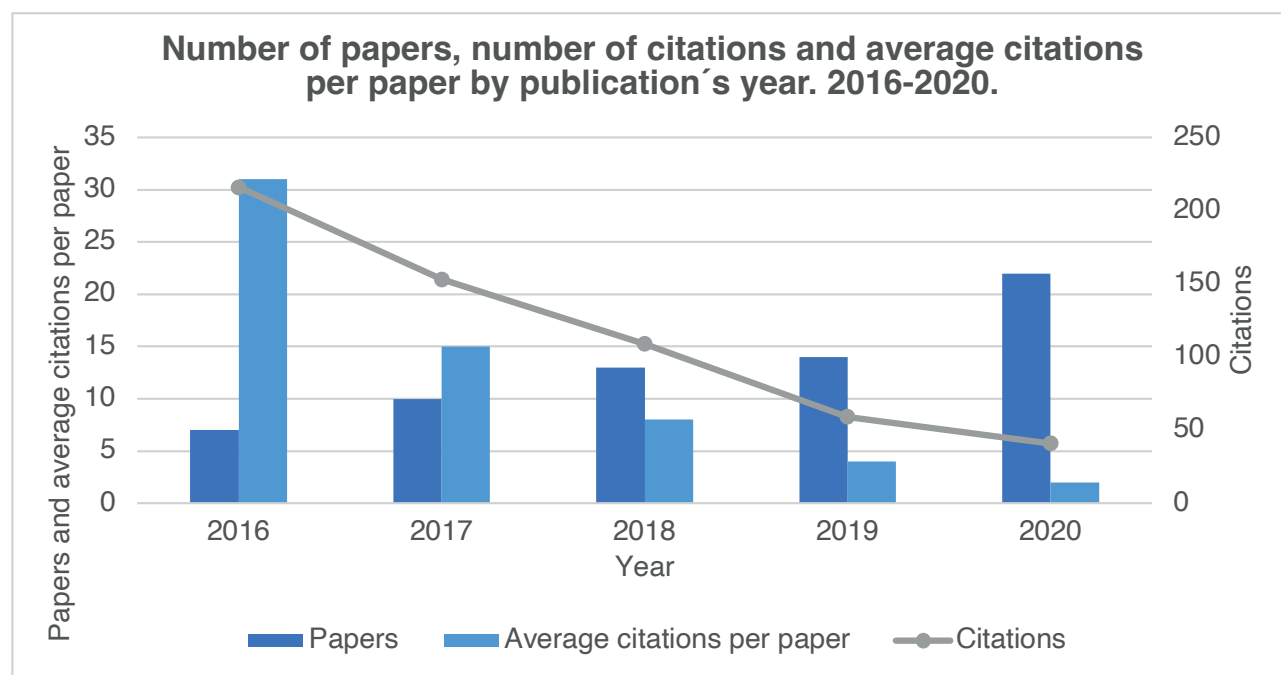


Figure 3. Trend of publications.

and, access in the blue cluster. Other applications are open cities present in 21% of the articles; in addition, 8% of the applications are in education and are related to knowledge for access and collaboration in cities and the public sector as identified in the blue cluster.

After keyword maps extracted topics, the analysis of the percentages with respect to the characterisation of the type of open data yielded further contextual information. In this regard, the 94% of the research articles deal with Government Open Data OGD, 5% with Research Open Data ORD and only 2% with private open data OPD. This scenario was to be expected since the literature search was conducted using OGD. Furthermore, regarding the Disciplines in which the use of OGD is applied, our

sample yielded the following: 85% of the articles focus on Social Sciences, 12% on Computer Sciences, 3% on Health Sciences. On the other hand, in a temporal analysis of how the subject of OGD use has evolved, with respect to the number of articles and citations, so the situation could change in the near future. The following graph visualises the frequency of articles by year and the average number of citations per article, and the line, whose axis is the right one, shows the total number of citations by year.

The number of scientific articles on this topic has increased yearly at an average annual growth rate of 34% and specifically in 2020 compared to 2019 with a growth of 57%. Which shows the increase of interest over the years in topics related to OGD usage. The number of citations decreases by an annual average of 34%, which is logical because, the newer the article, the fewer citations it may have at the beginning, and these increase as further research is conducted on the topic, and it is possible that they are cited over the years.

4.2. RQ2 What are the barriers to the use of open data, and, within those barriers, what role does technical and critical open data literacy assume?

To continue with the guided analysis considering the research questions, specifically RQ2 - What are the barriers that prevent the use of open government data? The analysis of relative frequencies of the barriers that prevent its use responds in first place to the lack of Open Data Literacy, which represents 65% of the cases. This classification includes technical literacy (with 62%) and critical literacy (3%), followed by 14% lack of data quality and 9% related to the lack of skills for access or basic use of the technology. To deepen the answer, it is necessary to perform a contingency table analysis to explore relationships between variables (i.e. the type of open data and the discipline) in which the identified barriers are present to a greater and lesser extent.

Therefore, to delve into the answers to the questions posed, RQ2 is represented by the barriers to use arranged in the columns, whereas in the rows the contexts, discipline, type of data, open data applications are showcased. Table 4 outlines the crossovers that exist between pairs of variables and at the same time it segments the responses to answer the questions posed.

The columns in Table 4 that show the barriers provide an answer to the question RQ2 and evidence that the most significant barrier that prevents people from using open data provided by the government is a lack of technical open data literacy skills. This is the case across all three context variables; more specifically, it is the barrier that is observed the most frequently in terms of discipline, type of data, and open data applications. The quality of the data is a persistent second obstacle that applies to all three factors. The third one is a limitation imposed by technology.

4.3. RQ3 What types of learning are promoted using open government data?

Similarly, to primarily answer the question RQ3 (what types of learning are promoted with the use of open government data?), when analysing the type of learning promoted, almost 38% of the articles show that technical open data literacy is generated, followed by civic education 26%, professional learning 23%, political participation 11% and only 3% of critical data literacy. It seems that the articles have paid attention to the technical aspects and data manipulation rather than to a critical and reflective analysis of the data. The answer to this question may be of great interest since it could lead to the applications that would arise from this learning, as well as the contexts in which they could be forged.

Table 4. Barriers that impede the use of OGD according to the context.

		Issues preventing usage (absolute frequency)					Issues preventing usage (relative frequency)				
		Critical Data literacy	Technical Data literacy	Quality of data	Technology	Not mentioned	Critical Data literacy	Technical Data literacy	Quality of data	Technology	Not mentioned
Open data											
Discipline	Computer sciences	0	2	4	2	0	0%	3%	6%	3%	0%
	Health	0	0	0	0	2	0%	0%	0%	0%	3%
	Social Sciences	2	39	5	4	6	3%	59%	8%	6%	9%
Type of Open Data	OGD	2	40	8	5	7	3%	61%	12%	8%	11%
	ORD	0	1	0	1	1	0%	2%	0%	2%	2%
	POD (Private Open Data)	0	0	1	0	0	0%	0%	2%	0%	0%
Applications of Open Data	Education and training	1	2	0	1	1	2%	3%	0%	2%	2%
	Governance	0	19	4	2	2	0%	29%	6%	3%	3%
	Industrial Innovation	0	11	3	2	4	0%	17%	5%	3%	6%
	Open cities	1	9	2	1	1	2%	14%	3%	2%	2%

Table 5. Type of learning OGD usage promote according to context.

		Types of learning generated (absolute frequency)					Types of learning generated (relative frequency)				
		Civic education	Critical Data literacy	Technical Data literacy	Political participation	Professional learning	Civic education	Critical Data literacy	Technical Data literacy	Political participation	Professional learning
Open data											
Discipline	Computer sciences	3	0	2	0	3	5%	0%	3%	0%	5%
	Health	2	0	0	0	0	3%	0%	0%	0%	0%
	Social Sciences	12	2	23	7	12	18%	3%	35%	11%	18%
Type of Open Data	OGD	16	2	24	7	13	24%	3%	36%	11%	20%
	ORD	1	0	1	0	1	2%	0%	2%	0%	2%
	POD (Private Open Data)	0	0	0	0	1	0%	0%	0%	0%	2%
Applications of Open Data	Education and training	0	1	1	0	3	0%	2%	2%	0%	5%
	Governance	8	0	12	3	4	12%	0%	18%	5%	6%
	Industrial Innovation	3	0	8	2	7	5%	0%	12%	3%	11%
	Open cities	6	1	4	2	1	9%	2%	6%	3%	2%

As shown for the RQ2, the Table 5 represents the crossovers between types of learning generated from OGD usage (columns), and the rows report the contexts, discipline, type of data, open data applications.

It has been discovered that technical literacy in open data is also the sort of learning that is promoted the most frequently in the same three variables that refer to the settings in which open data is used. In second place is the concept of civic education, which is defined as learning that is encouraged through the utilisation of open data. In third place is the concept of professional development.

5. Discussion

In order to address our research questions (RQ1, RQ2, and RQ3), we operationalized the embedded constructs into variables. They pertained to the classification of open data (types of open data, applications, and disciplines), the obstacles that inhibit the use of open data, and the forms of learning fostered by open data when utilised correctly. In two steps, we analysed the acquired data (articles referencing open government data).

As for a preliminary answer to question RQ1, we initially mapped and grouped the articles' keywords. This operation highlighted the settings of use in which OGD excelled at the national and smart city levels: as a social resource for civic participation and political transparency, and for collaborative usage relating innovation in public administration and society in general, consistently with the literature (Yin et al., 2015). Innovation is defined in terms of open data literacy as the process of developing new knowledge and learning based on OGD. This final piece also partially addresses RQ3, which is aligned with a new form of collaborative innovation, namely, civic society culture occurs when citizens reuse free data (Mergel, Kleibrink, & Sörvik, 2018).

In the second part of the investigation, 66 articles were classified into several fields and groups. Straightforward frequencies, contingency tables, and relative frequencies were estimated to answer RQ1 and RQ2 and RQ3 respectively.

The statistical study demonstrates that the highest proportion lies within the area of social science, with accessible government data serving as the foundation of governance. This prevalence is consistent with Altayar's (2018, p. 634) assertion that publishing OGD enables external parties to access, explore, manipulate, and discover government data, thereby facilitating the development and creation of beneficial services, products, and applications for the benefit of society and government institutions.

When coming to the barriers that limit the use of open data (RQ2), we observed that 62% of the articles referred to the lack of technical data literacy as a barrier to usage, followed by data quality 14% and in last place, critical data literacy with just 3%. The crosstabs show also that the lack of open data literacy stands out as the main barrier specifically in social sciences, government open data and governance. This is consistent with Matheus and Janssen (2020, p. 521) who indicate that the same data that creates a higher level of transparency for the expert, creates a lower one for someone with limited access and lack of knowledge on how to use it. While other studies discuss the absence of meta-data (Raffaghelli & Stewart, 2020) or lack of linkage in the data (Haklae, 2018), our results confirm the importance of data literacy.

Our analysis of the literature indicates that, when there is appropriate engagement with open data, there is learning (RQ3). Although our analysis mainly yielded concern around technical learning on open data, it focused at the same time on how the lack of this capability is also connected with its low usage, so there is consistency in the emphasis given to this type of literacy. Civic education is also promoted, followed by professional learning, but the two categories are less mentioned. Moreover, the keyword map shows that collaboration in the use of open data for innovation is a crucial factor, and this does not only refer to technical skills, but also to critical appraisal and engagement with open data. Indeed, considering D'Ignazio and Klein's perspective on intersectional feminism and data justice (2020), the processes of co-creation and collaboration enable new social balances, which is the main goal of open knowledge.

On the other hand, the percentages reveal a pattern in the categories with the highest frequencies of the row variables: the main barrier impeding the use of open data is the lack of open data literacy,

while the type of learning promoted with the use of open data is precisely open data literacy. The three main categories showcase that the frequencies are higher in the technical literacy barrier than in the technical literacy learning promoted.

Furthermore, in the categories (Discipline Social Science, Data Type Government Open Data, and Open Data Applications), the barrier of open data literacy is greater than the open data literacy learning promoted through open data usage. Quantifying this difference, it is of the order of 24% in Social Sciences, 25% in Government open data and 11% in the Governance application. Learning around open data is probably hindered by several barriers beyond the same actors' basic knowledge and skills (Ruijter et al., 2020; Zuiderwijk et al., 2015).

Overall, our analysis suggests that illiteracy is a significant obstacle, that most literacy possibilities are technological, and that engagement with open data creates real learning when it occurs. However, our investigation was unable to determine the extent to which collaborative and co-creative components could develop synergies between the public sector, business sector, academics, and citizens in general, at the local and national level, in pursuit of innovation and governance. These are the remaining parts of a comprehensive and critical data literacy that require investigation.

6. Conclusions

Our findings have allowed us to identify the importance of data literacy in general, despite the paucity of reflection on the type of literacy, specifically holistic and critical, that enables individuals to view data as a complex socio-technical construction. The ultimate purpose of open data is strongly contingent on the levels of literacy and the possibilities to engage with open data in such a way that reflection, skills, and hence learning can be launched.

Our study is subject to a number of important constraints. The literature search in the databases was restricted to government information. The classification of the articles into the categories described in the Codebook was based on the objectives of the study. It should be highlighted that some articles included more than one category related the primary variables but were coded into a single category for data analysis reasons. In this study, the skills of downloading, managing, and interpreting open data, which are distinguished in some articles as digital, computational, or technological skills, are framed within the concept of technical open data literacy and are distinguished from a holistic, politically and socially contextualised understanding, or critical open data literacy.

Moreover, it should be noted that this study is exploratory regarding the settings of open data use and the function of open data literacy, therefore it sets the basis without delving into suggestions or consequences for the professional practise of open data literacy. Yes, this requires future research with a deeper depth and concentration.

Nonetheless, we supplement our empirical study with references to the literature. In this regard, we found that our findings are complementary to what has been described as a new sort of collaborative innovation culture, which happens when citizens manage open data in a meaningful way. In this approach, not only publication, but also this type of OGD usage might spur innovation. This type of participation enables external parties to access, explore, and manage OGD, hence facilitating the development and construction of contextually useful services, goods, and applications for the benefit of local communities and the larger society (Altayar, 2018). Our investigation revealed that there may be a discrepancy between these optimistic assumptions, which pertain to the required abilities and knowledge, and the conditions necessary to develop these skills and knowledge.

Echoing the literature, we argue that the enabling conditions for the development of capabilities in citizens and professional actors to make open data accessible, reusable, and situated (Mergel et al., 2018) are dependent on their basic skills and the educational resources and activities that generate formal, non-formal, and informal learning around open data. For instance, the construction of data usage laboratories with broad participation from individuals and interested organisations would enable the emancipation of society through playful and economical forms of peer-to-peer learning. Workshops, seminars, massive open online courses (MOOCs), and virtual classes with certification may also be significant (Matheus, Maia Ribeiro, & Vaz, 2018), but it must be determined to what extent these learning modalities help active professionals or global citizens in their engagement with OGD. Overall, research should focus on the production of educational resources for the development of key skills required to function in a data-driven society (Atenas et al., 2020). Indeed, only a handful of the models designed for capacity building have been evaluated at scale (Davies et al., 2019), and there is a lack of knowledge on data literacy baselines, a dearth of systemic interventions to improve data literacy, and scant research on what works (Montes & Slater, 2019). According to our research, data literacy remains a significant issue in an evolving context dominated by intelligent technologies based on data extraction and algorithmic manipulation. Therefore, fostering a lifelong learning dimension should be considered a top priority for both public and private entities in the near future.

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Data literacy ecosystem development framework: Approach for bridging the gender gap in the digital economy of the Western Balkan countries

Il framework per lo sviluppo dell'ecosistema dell'alfabetizzazione dei dati: un approccio per colmare il divario di genere nell'economia digitale dei paesi dei Balcani occidentali

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ABSTRACT This paper is a position paper that is not based on formal research. Its purpose is to propose a Data Literacy Framework for support in the process of the bridging the gender gap in Western Balkans among women entrepreneurs. To succeed in today's data-driven economy, women entrepreneurs need data skills and digital skills to unlock opportunities and grow businesses. The focus of any successful business in modern economies is how to equip women with suitable data and digital literacy so they can pursue careers in the digital economy, to contribute to the digital transformation of the economy and the public sector, especially in the Western Balkans developing countries. The proposed Data Literacy Framework should be used as an instrument to devise public policy measures for providing education and training opportunities, design customised data literacy upskilling for women entrepreneurs, implement career guidance services, promote the role of the women in the digital economy, and provide support for more effective deployment of various concepts of the digital society.

KEYWORDS Data Literacy; Gender Gap; Digital Skills; Data Science; Women's Entrepreneurship.

SOMMARIO Questo articolo è un documento programmatico che non si basa su una ricerca formale. Il suo scopo è proporre un Data Literacy Framework per supportare il processo che mira a colmare il divario di genere nei Balcani occidentali. Per avere successo nell'economia odierna basata sui dati, le donne imprenditrici hanno bisogno di competenze in materia di dati e competenze digitali per aprire nuove opportunità e far crescere le imprese. L'obiettivo di una impresa di successo nelle economie moderne è dotare le donne di una alfabetizzazione sui dati adeguata in modo da poter intraprendere una carriera nell'economia digitale, e contribuire alla trasformazione digitale dell'economia e del settore pubblico, in particolare nei Balcani

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occidentali, paesi in via di sviluppo. Il framework per l'alfabetizzazione dei dati proposto dovrebbe essere utilizzato come strumento per promuovere misure di politica pubblica atta a fornire opportunità di istruzione e formazione, progettare un miglioramento delle competenze in materia di alfabetizzazione dei dati personalizzato per le donne imprenditrici, implementare servizi di orientamento professionale, promuovere il ruolo delle donne nell'economia digitale e fornire sostegno per una diffusione più efficace dei concetti della società digitale.

PAROLE CHIAVE Alfabetizzazione dei Dati; Divario di Genere; Competenze Digitali; Scienza dei Dati; Imprenditorialità Femminile.

1. Introduction

1.1. Background: the developing countries in Western Balkan

Despite the social and political instability, the Western Balkans region has clear aspirations to improve its economic competitiveness and increase the wealth of its citizens. Achieving these aspirations will position the region for further integration into Europe, as outlined by the European Commission's Strategy for the Western Balkans. One of the factors in this endeavour - continuous provision of a highly skilled population, is integral to creating the dynamic productive economies that the region desires. This is especially challenging in situations when these countries are facing intensive brain-drain trends, emigration and increasing skills mismatch on the labour market. Development of the data literacy skills and more generally digital skills is significantly a difficult task in these countries due to the inappropriate and low-quality education and training systems. Consequently, there is a shortage of skilful workforce that will be able support the digital transformation of these societies. Furthermore, there is a significant skills gap between the skills of the potential workforce supplied by the education and training systems and the skills required by the economies of these countries.

Having in view the firm dedication of these countries to exert fast digital transformation, which is clearly defined in their economic development strategies, the question about the planning of the development of their labour markets with provision of digitally literate and equipped with advanced digital skills workers becomes of utmost importance.

Bridging the gender gap for the digital economies of these countries could effectively contribute to successful realisation of the strategies in question. The digital divide and the gender gap are not only a problem of the developing countries of the Western Balkans. Even the most developed countries in Europe, including the democratic countries in Scandinavia, have not fully met the goals set by the European documents for women's equality (European Institute for Gender Equality, 2013). This assessment is confirmed by numerous research studies in the world, as well as in the Western Balkan. If digitization unites people on a global level, certain measures and activities are necessary to increase the share of women in the digital economy labour market. With the absence of appropriate data literacy and digital literacy among the female population, the gender gap increases, which creates appropriate repercussions in all social spheres. On the one hand, it results in reduced opportunities for the real inclusion of women in social processes, and on the other hand, it causes their personal doubt in the magnitude of their own values.

In order to discontinue this negative trend in the digital distribution of skills between the genders in the countries of the Western Balkans, we will try to encourage activity in the digital sector through specific measures and guidelines to support the development of data literacy and digital literacy com-

petencies, as a propulsive and dynamic factor, in which women will be able to present their own. In the future digitally based economies of this countries, these competencies will enable them to start new businesses, will be more presented on the labour market, have a more prominent role in decision-making processes, initiate new businesses and through appropriate programs they will be able to be networked at a higher regional and cross-border level.

1.2. The skills mismatch challenge

Skills mismatch and the potential mitigation solutions in Western Balkan has been the subject of many studies. Some of them, argue that the competitiveness of these countries “*is hindered by a lack of entrepreneurial and technological know-how, a significant skills gap, weak institutions and low levels of investment and infrastructure quality*” (Kyrkilis, & Nikolaidis, 2003).

Dealing with data literacy is seen as the job of data scientists, not average employees who generally have little to no formal training or education in working with data effectively. Additionally, academia has so far failed to keep up with enterprise demand for data literate graduates, meaning even younger, digitally native professionals often lack the competencies they need to work with the data (Shull, 2022) (Centeno, Karpinski, & Urzi 2022) argue that Europe, in general, is facing a significant gap in the digital skills. The digital skills mismatch has been ranked high in the EU priorities, and consequently in 2020 EU has set the ambitious objective in its European Skills Agenda to ensure that 70% of 16-74 years old have at least basic digital skills by 2025. EU has recognized that digital competence has become crucial for employability, and one of its key elements is the data literacy.

The GSMA study (GSMA, 2018) indicates that the share of women leaders in the technology sector in the world is uneven. Just for comparison, in Great Britain, which is considered one of the countries with the most democratic forms of governance, the representation of female leaders is only 5 percent. Overall, in the world, the GSMA study estimates that women are 26% less likely than men to use mobile Internet services. This equates to 327 million fewer women using mobile Internet than men. While mobile phone ownership is basically the same for men and women in China, women are 4% less likely to use mobile Internet. In Mexico, women are about 5% less likely to own a mobile phone and 10% less likely to use mobile Internet. Women are also limited in access to digital resources, lack of financial resources and fear of online safety. Such social distortions and disproportionalities discourage women for their more active approach in the technological sectors (OECD, APEC, 2019).

For any business-minded woman, developing digital competencies and knowledge of the concept of data literacy is an important means of accelerating her career. Digital tools, when properly structured and combined with appropriate self-management skills, increase her employability, opportunities for development and advancement in their careers.

The problem of under-representation of women in economically critical sectors - such as digital economy – and in relation to EU policies and initiatives to address the data literacy skills shortage, emphasizes the need to design and implement data literacy activities and training opportunities that will upskill/reskill and activate the female population in the target level of training, selection and participation in entrepreneurship and employment with a focus on, but not limited to, digital economy. This is an important cause for concern, due to the strategic importance of digital economy in achieving the EU’s goals of a more competitive international economy. The situation is alarming and worrying, but also promising for the future of young, qualified employees, who see huge potential in the application of digitization in the social ecosystem.

The low-quality education systems of the developing Western Balkans countries result in evident skills mismatch between the skills that possess participants on the labour market, and those required by the economy. This issue is impeding the planned digital transformation of these economies, due to the lack of the most valuable asset required for the transformation, i.e. the qualified and skilled workforce.

We identify the skills mismatch problem as a two-fold problem:

- continuous lack of digitally skilled workforce and
- underrepresentation of women in all occupations which require significant data literacy competencies and data skills

The solution is based on the premise that data literacy is the foundation for the development of digital literacy. Proper training for data literacy skills will contribute to supply of more quality digitally skilled workforce. The key data literacy competencies are related to understanding of and practical application of the knowledge related to *Data types, Data structures, Data sources, Processing Data (Collecting, Conversion, Analysing), Data visualisation, Data interpretation and storytelling*. The solution consists of four steps (strands): digital skills needs-assessment, data skills and literacy evaluation, career guidance and provision of training opportunities. Career guidance needs special focus on the gender gap in the digital economy and must take into account the specific needs of the women entrepreneurs.

A Regional Cooperation Council study (Andjelkovic et al., 2021) proposes development of a Methodological framework for a fully-fledged assessment of digital skills needs and gaps. It is based on approach that includes recognition of the digital competencies required for different sectors (areas of work) and job categories through interviews, deepening the findings of the obtained research through work with specific focus groups (in our case women entrepreneurs), preparation of general questionnaire, preparation of tailor-made, user-friendly questionnaires for specific target groups, sectors and/or industries (in our case women entrepreneurs). There is a set of digital competence indicators incorporated in the framework distributed in five competence areas: Information and data literacy, Communication and collaboration, Digital content creation, Safety and Problem Solving. However, the *Information and Data Literacy* area is constrained only to the following competencies:

- browsing, searching and filtering data, information and digital content;
- evaluating data, information and digital content;
- managing data, information and digital content.

For each of these competencies there are proposed questions, that are supposed to help the examination of the competencies, respectively:

- Is the employee able to use Internet search engines to find relevant information?
- Is the employee able to evaluate the reliability of information found on the Internet?

Can the employee save and store data, information and content (text, images, audio, video, internet pages) and retrieve them?

We argue that - although this approach is effective - still in the area of data literacy much more focus should be put on analysing the competencies related to *Data types, Data structures, Data sources, Processing Data (Collecting, Conversion, Analysing), Data visualisation, Data interpretation and storytelling*.

1.3. What is Data Literacy

Proper definition of Data Literacy is key for developing wide public understanding and increasing the sensibilisation about the impact of the data and data literacy on the development of the economies

and the efficiency of the public sector. There are multiple definitions of the term Data Literacy. According to Wollf, Gooch Montaner and Kortuem (2016), all these definitions are mainly forged around the eight areas of competencies with respective sets of skills. The *Inquire Process Competence* includes set of skills that are relevant for investigation, with analysis and interpretation of the gathered data. Hence, this competence includes two set of skills: Plan, implement and monitor the course of action; Undertake data inquiry process. The *Ethics Competence* includes all skills related to understanding the ethical use of the gathered and processed data. Further, the study suggests that third area of competence, *Real world problem-solving context*, encompasses set of skills for usage of data to solve real problems and understanding the role and impact of data in society in different contexts. The set of skills for identification of problems or questions that can be solved with data are part of the fifth area of competencies (*Ask questions from data*). The fifth and sixth area of competencies are related to developing hypotheses and identification of potential sources of data and collect/acquire data. Probably, the seventh area of competencies *Analyse and create explanations of data*, is the foundational area and it contains vast set of skills related to transformation of data into information and ultimately actionable knowledge, creation of explanations from data, accessing data, analysing data, understanding data types, converting data, preparing data for analysis, combining quantitative and qualitative data, using appropriate tools, working with large data sets and summarizing data. Finally, the “*Evaluation of the validity of explanations based on data and formulate new questions*”, the eighth competence area, encompasses the skills that enable critique of the presented interpretations of data and interpretation of information derived from datasets.

As result of their comprehensive analysis, Wollf et al. suggest the following definitions of data literacy:

Data literacy is the ability to ask and answer real-world questions from large and small data sets through an inquiry process, with consideration of ethical use of data. It is based on core practical and creative skills, with the ability to extend knowledge of specialist data handling skills according to goals. These include the abilities to select, clean, analyse, visualise, critique and interpret data, as well as to communicate stories from data and to use data as part of a design process.

We point to the last sentence of the definition, and we argue that the listed abilities must have central focus in the education and training programmes of the future workforce, and specifically for the women entrepreneurs professional development.

1.4. Evaluation, skills assessment, monitoring and skills verification

The digital transformation of the economy is not a new phenomenon. However, although it has been around for decades, there is a general consensus that the digital economy will create, destroy or replace jobs. There are many open questions in regard to this:

- Which sectors will be most affected?
- What new skills and qualifications will be needed to strengthen competitiveness?
- How will this sectoral transition take place?

There is no single answer to these questions. The global effects on the quality of employment, working conditions, forms of work can hardly be precisely assessed. In general, the risk, or the “dark side” of the digital revolution that threatens us, should be “illuminated” by strengthening digital knowledge and skills. If gender unequal representation in digitization is added to these problematic issues, then the concern has reached the point of real alarm.

The new generation of women entrepreneurs need specific data literacy training models and skills to advance their career development in general, but also enhance their deployment of digital technolo-

gies in the workplace for better efficiency, effectiveness and innovation. Research is clear that women sometimes lack self-confidence and trust in their own abilities. Therefore, encouragement and support from other women in social networks seems to be of great importance. This brings us to the conclusion that the support for the women entrepreneurs in the digital age needs much more than training opportunities. We think about support ecosystem that will encompass education and training, networking and peer support, institutional capacities, inter-institutional links, monitoring and evaluation, developing supporting policies. Creating appropriate evidence-based policies requires systematic data collection aimed at identifying priorities and defining and monitoring key lines of action. The analysis suggests that there is strong potential for positive policy action to provide the fundamental foundations to bridge the digital gender divide and build a more inclusive digital future.

Gender equality advocates are unique in their view of the seriousness, importance, and relevance of gender equality in all social domains. For this purpose, certain recommendations have been identified that relate to achieving better results in supporting the representation of women in the digital economy:

- knowledge and access to data literacy and opportunities for training to acquire basic skills are insufficient to promote equal access and participation of women in the digital economy;
- the increased involvement of women in the development of educational content that corresponds to their needs and priorities deserves more attention;
- younger women have greater opportunities to overcome data literacy knowledge and participate in jobs and environments with data literacy skills;
- a critical starting point for achieving gender balance in the digital economy is high-level education.

However, the existence and deployment of quality education and training opportunities requires continuous process of refinement and tuning to the needs of women entrepreneurs. This can be facilitated with a set of instruments and processes for evaluation of the training programmes and institutions that are implementing them, assessment of the women entrepreneurs data literacy knowledge and skills, monitoring of the overall enhancement of the impact of the data literacy at institutional and social level. Evaluation and assessment can provide valuable input for the designers of the education and training programmes so they can design more effective content and instructional methodology that suits the needs of the women entrepreneurs.

The enormous potential and unlimited possibilities offered by data literacy are the basis for defining clear recommendations for public policies for women entrepreneurs in the digital environment. Such actions and initiatives will make it possible to strengthen, promote and support the active participation of women as entrepreneurs and employees in the digital economy, as well as in other sectors of the economy.

2. Formal education: accurate defining and maintaining the learning outcomes

Education within any national economy is the main cornerstone on which the country's future competitive directions depend. According to certain studies, entrepreneurship is a feature of only about 2% of the world's population, but with permanent education and appropriate training, a larger part of the population can be encouraged to develop their entrepreneurial abilities and creativity (Temjanovski, 2018).

In order to overcome such obstacles, the education sector plays a major role. To this end, the Euro-

pean Commission is fully committed to increasing the participation of girls in ICT and Science, Technology, Engineering and Mathematics (STEM - Science-Technology-Engineering-Math) and continues to encourage Member States to address the gender segregation in education. The Digital Education Action Plan (2021-2027), presented in September 2020, defines measures to improve the development of digital skills in education and training, including guidelines to encourage the participation of women in STEM, which is led, inter alia, in collaboration with the European Institute of Innovation and Technology. The plan emphasizes the need to ensure that girls and young women are equally represented in digital studies. Similar to these policies, a European skills agenda was adopted in July 2020, where the Commission proposed to work in close cooperation with EU member states to implement measures to promote gender-balanced participation in ICT-related occupations. These measures include increasing the proportion of women studying science, technology, engineering and mathematics and encouraging women taking roles in the realm of entrepreneurship. In the future global economy, effective participation of women in entrepreneurship would be almost impossible without acquiring satisfactory level of digital skills, and therefore data literacy skills. Women entrepreneurs need to be quickly trained and involved in digital transformation processes of the economy. Fast results could be achieved through high quality professional development training courses. However, appropriate impact on the long-term supply of qualified women entrepreneurs workforce for the future economy could be only achieved through careful design of education and study programmes in the formal education, i.e. all levels. The design process should be focused on defining learning outcomes around the data literacy skills as defined in the Pillar C of our Framework. This could be vertically emphasized in the IT or computer science subjects and study programmes, as well as horizontally in the curricula of the other non-IT subjects and study programmes (in humanities, social sciences, natural sciences and engineering, etc.).

3. The need for creation of data literacy framework

The enormous potential and unlimited possibilities offered by the digital tools and solutions are the basis for defining clear recommendations for public policies for women entrepreneurs in the digital environment. Such actions and initiatives will make it possible to strengthen, promote and support the active participation of women as entrepreneurs and employees in the digital economy.

Greater involvement of women in scientific and inventive activities is good not only for women themselves, but also generates stronger economic growth and improved social well-being. Innovation resulting from mixed teams or groups (diversity carries value, both social and economic), appears to have broader technological dimensions than those involving men. Therefore, it is estimated that such programs can be economically far more valuable and long-term sustainable.

Programs for the application of digital technology for new knowledge and professional restructuring, especially among women with a different profession, must be implemented by well-trained staff and competent persons. In the context of professional development, competence refers to one's capacity to apply a set of related skills, knowledge, and attitudes for the successful performance of critical job functions, in the given profession. The set of competences needed for a particular profession are described in a Competence Profile (CP); a CP provides insight in the functioning of professionals within the specific job context and can be used as a starting point for the professional development within this context (Papamitsiou et al., 2021, p.2).

Competence Profiles should adopt a systematic process for using data in order to bring evidence to bear on their instructional decisions and improve their ability to meet woman's digital learning needs.

Information profiling should offer new opportunities and new challenges, new digitized programmes, which will strengthen the profiling of women, either on the labour market or as independent entrepreneurs. Therefore, it is necessary to design frameworks that will sustainably contribute the development not only the data literacy skills but will depict the entire support system for initial education, professional development of women entrepreneurs and their integration into the economy. Most of the existing frameworks are focused only the skills acquisition.

Prado and Marzal (2013) proposed a framework as a reference for incorporating data literacy into library information literacy training programmes. The framework includes five generic dimensions, it associates competences to each dimension, and translates these competencies into instructional topics to facilitate interpretation and direct implementation. The dimensions and respective competences are:

- understanding data, i.e., general knowledge and awareness of data, how they are generated and what are the different types and sources of data;
- finding and/or obtaining data, i.e., skills required to access/assess data sources;
- reading, interpreting and evaluating data, i.e., competences relevant to presenting data and to critically evaluating them;
- managing data, i.e., skills related to metadata data management repositories and data reuse; and
- using data, i.e., skills and knowledge required to properly and ethically handle and synthesize data.

Although the proposed scheme aspires to be universal, the key to its success lies in the depth to which it is developed, after adaptation to each library's particular needs.

However, the foundation for the development of all these skills are the data literacy skills. Most of the studies however refer to the acquisition and use of digital skills among women entrepreneurs. Future research on data literacy skills, including assessment of the related competencies, are needed to design more effective education and training programmes.

The data from EUROSTAT (2019) represents individuals who have basic or above basic overall digital skills by sex. Digital skills indicators are composite indicators based on selected activities related to using the internet or software applications conducted among people aged 16-74 in four specific areas: information skills, communication skills, problem solving skills, software skills. The data shows that women with the highest levels of digital skills are found in countries in Northern Europe, the Scandinavian countries and Benelux, such as Iceland (80%), Norway (77%), Finland (80%), the Netherlands and Switzerland (77%), Sweden (65%), Denmark (66%), and the lowest basic knowledge of digital skills among the countries of the Western Balkans: Albania (23%), Bosnia and Herzegovina (33%), Kosovo (24%) and in North Macedonia (31%). This group also includes women in Turkey with a digital competence value of (26%).

Similarly, data from the OECD Business Survey of Small and Medium Enterprises (SMEs) registered on Facebook (April 2018) shows that 65% of management positions in SMEs are held by men. According to the survey, only one in three SME representatives have mainly female management, and only one in four SMEs has a gender-balanced management team (OECD, 2018).

The main findings and conclusions of experts from various fields for the successful handling of women in the digital economy can be summarized in the following few points:

- women's careers due to family responsibilities – may be disrupted or fail; therefore, women must learn how to be flexible and rational in fulfilling professional obligations;
- women managers and entrepreneurs develop at work; they also develop their data literacy skills at work;
- women managers and entrepreneurs are oriented towards practice in relation to the digital transformation;

- digital transformation offers opportunities for career advancement, especially for women;
- to avoid the danger of burnout, digital technologies should be properly adapted and combined with management skills;
- women need encouragement, but also appropriate role models and networks to find their digital career paths.

We must apostrophize the key recommendations for the implementation of public policies to overcome gender inequality and which are of equal importance to all stakeholders, to ensure access and improvement of businesses and the use of business opportunities through digitization and the use of new digital opportunities. Namely, they are extremely important for those who make the legislation to support business and entrepreneurship, but also for those who implement the legislation. The six findings and conclusion imply that the solutions for bridging the gender divide in the digital economy need more than just provision training for professional development.

Holistic approach is needed that will create entire ecosystem for support of women entrepreneurs who will actively participate in the digital transformation of the economies in the Western Balkans; the ecosystem must ensure sustainability and continuous improvement of the policies, in addition to the provision of quality education programmes in formal education and appropriate professional development courses for women entrepreneurs already participating on the labour market.

4. The proposal for design of women entrepreneur's data literacy ecosystem development framework

We propose introduction of the term Women Entrepreneurs Data Literacy Ecosystem. We define the Women Entrepreneurs Data Literacy Ecosystem as interlinked elements that provide sustainability of Data Literacy among the individuals and institutions. The functions of these elements are to support the identification of the talent and development of the skills, perform their evaluation, provide advisory on the career guidance, build the institutional capacities to utilize the data literacy and contribute to its development, conduct analyses and research, design training programmes, and other functions. The elements of this ecosystem are the women entrepreneurs in different roles, the education and training institutions, companies, public institutions, research centres, etc. The roles of women entrepreneurs in this ecosystem may be individuals who poses, develop and apply data literacy skills, network contact points in various institutions, advisors, counsellors, evaluators, corporate managers or decision makers.

We organize these elements and their functions into a Development Framework to support the sustainable development of the Women Entrepreneurs Data Literacy Ecosystem. The four pillars of the framework we propose are: Institutional and Social support; Continuous Evaluation and Monitoring; Data Literacy Education and Training Opportunities; Networking and Communication shown in Figure 1.

4.1. Pillar A: Institutional and Social Capacity: leadership knowledge and understanding of the data literacy for women entrepreneurs to build ecosystem to support their progress/development

This pillar is key for institutionalization and provision of leadership for the functioning of the ecosystem. The main element in this pillar is a formal entity i.e. an organisation active in the area of promotion of women entrepreneurship, that will develop its capacities and infrastructure, setup the vision, advocate for women entrepreneurs and their role in the digital economy and their place on the labour market.

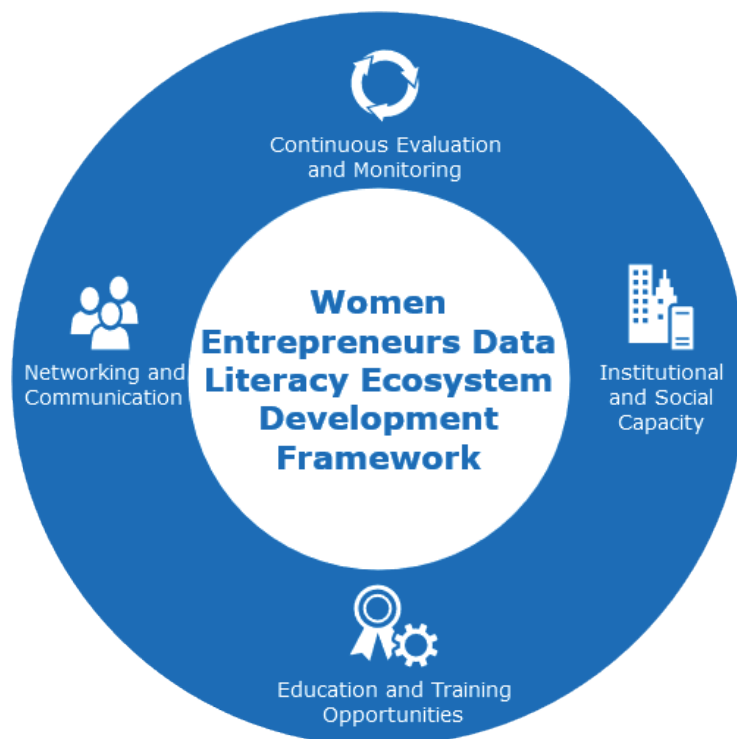


Figure 1. The pillars of the women entrepreneurs data literacy ecosystem development framework.

The Institutional and Social Capacity pillar is based on:

- 1) Institutional Capacity Development: establishes a formal entity, organization, to advocate for the women entrepreneurs professional development opportunities, work on promotion and sensibilization, evaluate the progress of women entrepreneurs, propose policy measures. The institution must position itself to be able to contribute to the national entrepreneurship and digital development strategies emphasizing thereby the interests of women entrepreneurs.
- 2) Leadership Capacity Development: commitment to building society-wide professional development practices for data literacy. The widely accepted vision exists around what data literacy is, and how it contributes to the development of entrepreneurship ecosystem.
- 3) Fundraising: Certain elements of the Ecosystem perform the function of fundraising to financially support the implementation of the activities and contribute to sustainability. The key responsibility for this function will have the established organisation.
- 4) Management: the organisation will be responsible for the management of the functions in the other three pillars of the framework. The organisation should manage and develop the necessary infrastructure, such as online platforms, databases, facilities, etc.

4.2. Pillar B: Continuous Evaluation and Monitoring of the Data Literacy Skills and Competencies.

This pillar is essential for validation of the data literacy skills and competencies among women entrepreneurs. It will cover data literacy skills acquisition at all education and training levels and during the professional development of women entrepreneurs. The findings, results, and reports that will be outcomes

from the evaluations, assessment and monitoring will serve as an input for the design and development of the education and training programmes. These functions can be performed internally (by schools, universities, companies, training centres) or externally (by accredited assessment/examination centres).

The Continuous Evaluation and Monitoring pillar foundations are:

- 1) Evaluation and assessment design: methodology for evaluation and assessment designed. The methodology considers various domains of knowledge for women entrepreneurs (finance and banking, industry and construction, etc.).
- 2) Evaluation and assessment deployment: tools and instruments developed and deployed to facilitate the data literacy evaluation and assessment of women entrepreneurs. Tools provided and staff and students trained in agile evaluation processes.
- 3) Monitoring procedures: these should enable processes for monitoring the women entrepreneurs professional development and provide input for career guidance. Training needs assessment to be performed.

4.3. Pillar C: Data Literacy Education and Training Opportunities

The Data Literacy Education and Training Opportunities pillar should be continuously providing education content/materials and training programmes that will be incorporated into the relevant subjects' curricula in the formal education and in the portfolio of programmes of the training institutions, respectively. Online training courses, and the production of digital content, is especially important for the professional and career development of women entrepreneurs. Asynchronous learning opportunities combined with quality tutorship is especially convenient for the women entrepreneurs.

The design of the training programmes must be based on the principle that skills related to *Data types, Data structures, Data sources, Processing Data (Collecting, Conversion, Analysing), Data visualisation, Data interpretation* and *storytelling* are the foundation of the Data Literacy. The rationale behind this principle is that proper mastering of these skills will make application of any higher-level digital skills more effective and efficient.

This process of design and development must be continuous and should take into account the results and findings from the evaluation and assessment of the digital skills acquired by women entrepreneurs. The objective of such approach is to provide improvement of the training progress and their adjustments to the actual needs and technological trends.

Certification and tracking of the progress in acquisition of the data literacy skills is recommended, to ensure higher motivation and competitiveness among women entrepreneurs.

The Data Literacy, Education and Training Opportunities pillar is based on:

- 1) Training programmes design: continuous data literacy training programmes design based on relevant data literacy skills anticipation approach. Learning outcomes relevant for entrepreneurs; focus must be on concepts closely related to innovation, such as Open Data.
- 2) LMS & Content development: Deploy infrastructure and produce digital content for the LMS.
- 3) Regular and online training programmes development: incorporate programmes design, digital content and needs assessment in the process of development of the programmes.

4.4. Pillar D: Networking and Communication

Networking and communication pillar is essential for creating the synergy among all elements in the ecosystem, and to provide instruments and content for effective outreach of their activities. Institu-

tions that are elements of this ecosystem should set up contact points to support the creation of synergy in the ecosystem (inter-institutional links), exchange of information and good practices, and to influence decision making that is relevant for the progress of women entrepreneurs in the digital age. These inter-institutional links can be supported by associations of women entrepreneurs; one example of such institution is the National Platform for Women Entrepreneurship in the North Macedonia.

The Networking and Communication pillar foundations are:

- Communication and Visibility: support the professional development of women entrepreneurs by provision/publishing knowledge products, case studies, analyses, and successful practices of the use of data skills in development of business models, cases, products, etc. Furthermore, this function provides promotion, understanding and awareness raising instruments. Setting up a shared language about women entrepreneurs' significance and achievements, and the role of data literacy in the digital age.
- Networking: setting up a wide network of contact points in companies and research organizations. The synergy among contact points will ensure and inspire cooperation, exchange of good practices, and creating constituencies for raising the question on the political agenda.

5. Conclusion

This position paper proposes establishing a Data Literacy Ecosystem to support the initial and continuous progress of the women entrepreneurs in the digital economy. This ecosystem that encompasses not just design and provision education and training opportunities, but is also upgraded with Monitoring, Evaluation, Networking and Career Guidance *functions* as a foundation for a holistic approach for support of women entrepreneurs in the times when skills gap becomes an immense problem for digital transformation of the economy. *Elements* of this ecosystem are women entrepreneurs, companies, training centres, schools and universities, and public institutions each of them with specific role(s) in realisation of the function of this data literacy ecosystem.

Data literacy, of course, remains critical to success in almost any business endeavour, and data and analytics initiatives will be a cornerstone of any company's competitiveness and success. But must bear in mind that creating a high level of data literacy culture, or a set of practices that bring together digital data talent, and tools, will become the most important and basic support for company operations.

Strengthening digital literacy will enable business policymakers to make better decisions within their current workflow, keep what works and improve it by supporting the analytics process derived from digital data.

The proposed framework will be the ground for policy makers to design effective public policy measures that will result in provision and continuous supply of digital ready young women entrepreneurs, by supporting the upskilling of the existing women entrepreneurs to be ready to support the fast digital transformation of the economic sectors they are working in. The recommendation from this study is that governments need to have holistic approach and to provide support ecosystem based on the proposed framework in this study for women entrepreneurs to enhance their employability and performance in the digital age.

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