Better ready than just aware: Data and AI Literacy as an enabler for informed decision making in the data age

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Abstract: Data and AI literacy is an important enabler for informed decision making in the data age. To inform educational programs and policies, it is important to create a common understanding about the required knowledge and skills. In this paper, we propose a novel taxonomy to data and AI literacy based on qualitative literature analysis and expert group discussions. We introduce three key roles related to Data and AI Literacy: the informed prosumer, the skilled user, and the expert creator. Moreover, we argue that Data and AI Awareness as the lowest level of understanding and recognizing is a necessary prerequisite but not a sufficient condition to Data and AI Literacy. We rather equate Data and AI Literacy with Data and AI Readiness. Further work will focus on defining the core knowledge, skills and competences of the taxonomy.

Keywords: Data Literacy, AI Literacy, AI Skills, AI Readiness, Competences, Taxonomy

1 Motivation

Data has long determined our everyday lives. Whether it's a search on Google, navigation in the car, suggestions in the online shop or the credit rating at the bank. Far too often, we are unable to make informed decisions for or against data, data sharing and data use. In some cases, we are neither aware nor prepared to deal with data and digital technologies in everyday life and at work. The current developments around generative AI increase the challenges (but also opportunities) that go hand in hand with this.

This realisation emphasises the great need for data literacy and AI literacy for everyone. But what does that mean? Data and AI literacy is needed on various levels, depending on specific roles of a society's members, to weigh up the opportunities and risks of data and data analyses in a sensible way and to be able to make informed decisions in private and in professional situations. One needs to be aware and, even more, one needs to be ready for the data age.

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Each and every one of us, whether the highest decision-maker at the national or even international level or simply as a private individual, is continuously exposed to a flood of data. Data-informed and algorithm-supported decisions have to be made in everyday life.

In the 1992 United Nations Agenda 21, one reads, "In sustainable development, each individual is a user and provider of information in the broadest possible sense." Data and AI literacy is to be understood in an equally broad sense. It includes not only a tool set or skill set, but above all a mindset: to critically question the quality of data and information sources; to be able to separate facts from opinions; to recognise the limits of data, including the capabilities and limits of AI applications and algorithms. And to make the right decision based on this recognition.

Our contribution intends to create a common understanding of data and AI literacy which aims to support appropriate and practical education programs along the entire education chain. Education that enables informed action and decision-making in dealing with data and artificial intelligence.

Given that, our data and AI literacy concept is the basis for eventually developing a convergent, coherent literacy assessment, measurement and impact evaluation framework for the national, regional and global levels that can help to fill the empirical evidence gap on outcomes from data and AI literacy interventions and programs.

1.1 Conceptual and theoretical foundations

The work of our research group is based on years of engagement with data literacy and increasingly also with AI literacy and AI skills. A central result of an initial, predominantly German-speaking community on data literacy was a Data Literacy Charter, which was published in 2021 [Sc21]. In this charter, data literacy is defined, following [Ri15], as "the ability to collect, manage, evaluate and apply data in a critical manner" [Sc21, Ri15]. A definition for AI literacy that has been widely cited in recent years has been developed by [LM20]: "AI literacy is a set of competencies [*sic*] that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace."

Combining these conceptional considerations we argue that data literacy and AI literacy cannot be separated from each other as data serves as the fuel for AI. Developing data and AI literacy is therefore crucial in today's technological landscape to harness the power of data and AI responsibly, enabling individuals to ask relevant questions, navigate through complex algorithms, interpret data- and AI-driven outputs, and critically evaluate their implications; generally speaking, to be able to make informed decisions in the data age.

To further specify this idea, amongst others the IEEE Standards Association has attempted a comprehensive definition in one of its standards, which is a central basis for many of the aspects to be discussed later: "Data and AI Literacy is the ability to generate, process, analyze, present meaningful information from data and develop, use, and apply artificial

intelligence (AI) and related algorithmic tools and strategies in order to guide informed, optimized, and contextually relevant decision-making processes." (IEEE 3527.1™ Standard).

1.2　Related Work

Related competence frameworks are partly more specific, partly more general. Examples include the European Unions' Digital Competence Framework for Citizen (DigComp) [Vu22], the HFD Data Literacy Framework [Sc19], the IEEE 3527.1™ Standard on Digital Literacy, Digital Skills, and Digital Readiness, the basic data literacy framework [Ai21] as well as work focusing on competences for AI literacy [LM20, Ng21]. Laupichler et al. [La22] recently scoped the literature specifically for AI literacy and found the topic is still in an early stage in higher and adult education. Multiple works build on defining roles or groups of stakeholders [Ai21, Wi18, Fa21] or using steps of action through a process in order to define competences [Sc19, Ai21]. At the same time, there is currently no clearly defined set of skills and competences over multiple frameworks and we are only beginning to understand the impact of data and AI literacy to society [La22].

2　Methodology

Methodology Literature research, qualitative content analysis [Ma04] and group discussions [Bo10] were the main methods used for this study. The methodology connects this study to the authors' involvement in the IEEE Working Group on "Data and AI Literacy, Skills and Readiness". In this working group international data and AI literacy experts meet regularly to develop a new IEEE standard. Thus, the results of the literature research and the qualitative content analysis could be presented for discussion in this working group. This mix of methods is suitable for gaining new insights into the meaning of definitions, roles and competences in the area of data and AI literacy.

Sample and Data Collection In the course of the literature review, more than 90 competency frameworks and curricula related to data literacy and AI literacy were identified worldwide. This semi-systematic review leads to an overview of the global activities in this field and is the starting point for the qualitative content analysis. The competency frameworks were then subjected to a qualitative content analysis. Particular attention was paid to the description of processes, roles and the specific descriptions of the data and AI competences. In addition, the described competences were assigned to different competence levels. The results of these qualitative content analyses were subsequently presented for discussion in the focus group of IEEE experts and thus assessed and validated. The data collection thus followed a mixed methods approach and is characterised by different perspectives on the object of study.

Validity and Reliability To ensure validity of this study's results, various scientific techniques were used. For example, qualitative content analysis was conducted by

independent coders to verify classifications between individuals. Additionally, feedback was sought from individual IEEE Working Group members to accurately represent their expertise and opinions.

3   Data and AI Literacy: From Awareness to Readiness

The discussions with education experts have shown that there are indeed some general bases for addressing knowledge, skills and competences. For example, Bloom's Taxonomy or a version supplemented by Anderson and Krathwohl served many experts as a central reference for the question of how knowledge, skills and competences can be transferred into learning outcomes. A simplified representation according to Rampelt et al. [Ra22] defines the descriptors "reflect" and "understand" at the knowledge level and the descriptors "apply", "analyse", "assess" and "create" at the skills level (or application and problem-solving) (see Tab. 1). These form a good basis for the question of what is meant by AI literacy in relation to the concept of AI Readiness.

Dimension	Level	Description
Knowledge	1	Remember
	2	Understand
Application and Problem Solving	3	Apply
	4	Analyse
	5	Assess / Evaluate
	6	Create

Tab. 1: A taxonomy of learning [Ra22] based on Bloom's Taxonomy

We further developed the basic taxonomy of [Ra22] and applied it to the principles and definitions from the Data Literacy Charta [Sc21]. In this context, we derived a new taxonomy to describe the concepts of data and AI Awareness and Readiness (see Fig. 1). It proposes seven literacy levels in the field of data and AI, namely (1) Understand and Recognise, (2) Consume, (3) Provide, (4) Collect, (5) Manage and Protect, (6) Evaluate and Analyse, and (7) Create and Develop.

We argue that the first level, "understand and recognise", corresponds to the characteristic of general awareness. Data and AI awareness refers to having a basic understanding and knowledge about data and AI, its characteristics, and its potential applications. Levels 2-7, according to our working hypothesis, are characterized by Data and AI Readiness. This is what we understand as the core of Data and AI Literacy. Data readiness describes the ability to apply such (basic) understanding in an informed, responsible, and outcome-oriented manner in private and professional practice. AI Awareness is, therefore, a necessary prerequisite for AI Literacy, but not a sufficient condition.
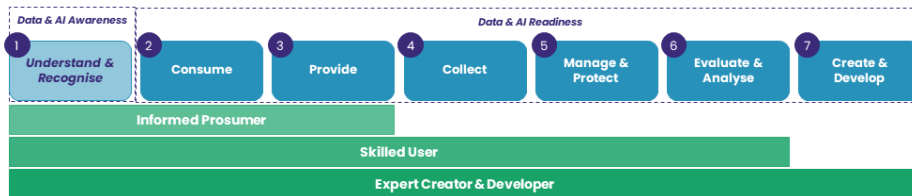
Fig. 1: Data and AI literacy levels and corresponding roles.

To describe data and AI readiness and the respective competences, it has shown useful to define exemplary roles as well as to match competences to these roles (see Fig. 1). The underlying idea is that competences are individual enablers and their respective levels depend on specific roles that are expected to fulfil certain tasks. In this context, each level might be present in different complexity depending on the role.

We identified three main roles that we describe as follows:

Informed Prosumer: A person who produces and consumes data and AI in an informed way. Thus, the informed prosumer is aware of and recognises the importance of data and AI in the world and takes a conscious decision to provide and consume data and AI tools.

Skilled User: A person who uses data and AI in a skilled and responsible way, including application-relevant skills that go beyond consumption and sharing. These include collecting, managing and protecting data, as well as the ability to evaluate and analyse data.

Expert Creator: A person who creates new insights, solutions, and tools with and based on data and AI. In this context, the creation and development go beyond sole application and usage of data and AI.

4   Discussion and Outlook

In conclusion, we have presented a novel taxonomy for data and AI literacy that is based on a combination of qualitative literature analysis and expert group discussions. This taxonomy introduces seven literacy levels that contribute to informed decision-making processes. In this context, literacy includes not only knowledge of data and AI but also attitudes and values towards it. Moreover, the taxonomy defines three major roles or groups, namely informed prosumers, skilled users, and expert creators, which help to distinguish and describe levels of proficiency in data and AI literacy and to further elaborate on its application in practice. We have also highlighted the importance of moving beyond data and AI awareness as the foundation of understanding. While data and AI awareness is necessary, it is not sufficient to achieve true literacy and data and AI readiness.

Overall, this work creates a common understanding of data and AI readiness and can support work on defining policies, competence frameworks, education curricula and the preparation of the digital and data-driven society. It can support policy makers, curricula designers in institutions and companies, educators, and individuals. Specifically, this work will contribute to the development of an official IEEE standard on Data and AI Literacy, Skills, and Readiness to be finalised this year. Further research will focus on providing competence indicators per role, to further elaborate on the actual roles in regards to their application in practice and to provide a basis to assessment and impact evaluation of interventions and programs.

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