DATA-READY

Empowering Education through Data Literacy Integration in Compulsory Education

DATA READY

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D2.2 Data Literacy Framework for Compulsory Education (Working Draft v1.0)

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1 Introduction

1.1 The project

The project DATA-READY (Empowering Education through Data Literacy Integration in Compulsory Education) arises from the increasing recognition of the critical role data literacy plays in modern education. In a world where data influences nearly every aspect of daily life, the ability to understand, analyse, and use data effectively has become an essential skill.

Data Literacy (DL), the ability to derive meaningful information from data, is now considered a crucial component of overall literacy, alongside reading, writing, and numeracy skills. DL encompasses a broad range of skills, including data collection, analysis, interpretation, visualization, and ethical use. These skills enable individuals to make informed decisions, solve problems, and communicate their findings effectively. Moreover, DL represents a new dynamic scientific field, closely related to developments in ICT, Computational Thinking and STEAME and is recognized as a fundamental component of digital literacy, as it encompasses the ability to understand, analyze, interpret, and communicate data effectively.

While there is not a unique definition of DL, DATA READY D2.1 (2025) defines it as the ability to understand, analyse, interpret, and communicate data effectively, emerges as progressively more critical literacy/ is emerging as an important literacy for preparing students to navigate a data-driven world[1].

In an era marked by rapid technological advancements and an explosion of data, these competencies are crucial for both personal and professional development. Recent studies and educational frameworks, such as the European Commission's DigComp 2.2 and the Digital Skills Indicator 2.0, highlight the need for comprehensive digital competencies, including DL, to prepare students for the demands of the 21st century.

However, despite its importance, DL is not yet systematically integrated into the curricula of compulsory education across many European countries. Traditional curricula often focus on basic literacy and numeracy, leaving a significant gap in the teaching of data-related skills.

Recognizing the importance of DL, several international organizations and educational bodies have emphasized the need to incorporate data literacy into curricula and teacher training programs. However, the implementation of DL education remains fragmented and inconsistent across different countries and educational systems.

The DATA-READY project aims to address this gap by developing a comprehensive framework for DL in compulsory education (primary and low secondary) and enhancing the capacity of teachers to cultivate these skills in their students. By focusing on the foundational years of education, the project seeks to equip future generations with the necessary competencies to navigate the data-rich world they will encounter, addressing also the priorities set out by the Digital Education Action Plan 2021-2027.

The project is grounded in the belief that fostering DL from an early age can have far-reaching benefits. It can nurture critical thinking, problem-solving, and decision-making abilities in students, empowering them to make informed choices in their personal and professional lives. Moreover, data-literate citizens are better equipped to participate in democratic processes, understand complex issues, and contribute to evidence-based policymaking.

[1] D2.1 p. 19

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By developing a comprehensive framework, the project aims to provide a structured approach to DL education, ensuring consistency and coherence across different educational systems. The framework will identify key domains, learning outcomes, and progressions, enabling teachers to effectively integrate data literacy concepts into their classrooms.

Furthermore, the project recognizes the crucial role of teachers in facilitating DL education. By enhancing teacher training programs and providing professional development opportunities, the project aims to build the capacity of educators to effectively teach DL skills and incorporate them into their pedagogical practices.

Through a collaborative and transnational approach, the DATA-READY project seeks to foster mutual learning, share best practices, and promote evidence-based policymaking in the field of DL education. By addressing this critical need, the project has the potential to contribute significantly to the development of a data-literate society, capable of navigating the complexities of the modern world and making informed decisions for personal and societal well-being.

In this context, the DATA-READY project aims to develop, implement and test a new policy approach to enhancing DL skills of students in compulsory education (primary and early secondary). The DATA-READY will design and pilot a comprehensive and innovative European framework for DL skills in education and in parallel develop and effectively deliver capacity building training programs for teachers, following a specific methodology, as outlined below:

- During the project, partners will conduct a comprehensive mapping of existing DL strategies, policies, and practices in national curricula across partner countries.
- Based on this analysis, the project will develop the European-wide framework defining domains, learning outcomes, and progressions for DL skills in compulsory education. The DL Framework (DLF) will provide a comprehensive, structured approach to developing core DL competencies among primary and secondary school students. It will outline essential skills, proficiency levels, performance indicators, and implementation guidelines for utilizing DL into curricula. DLF will also include supporting resources for educator training, evaluation methods, and governance structures to ensure its relevance and sustainability.
- Next step will be the capacity building of teachers and the experimentation phase with students.
- Based on the experimentation results, the project will propose evidence-based policy recommendations for transferability and sustainability of data literacy education strategies. The planned research, analysis, and experimentation phases will generate evidence-based insights and recommendations to inform policy making on data literacy education at national and European levels.

The DATA-READY project, by developing a comprehensive framework for DL skills in compulsory education and providing resources for teacher training and professional development, will equip educators with the necessary tools and guidance to cultivate these essential competencies in their students from an early age.

By establishing clear competencies, proficiency levels, and implementation guidelines, the DATA-READY framework will facilitate the utilization of data literacy into curricula and pedagogical practices, enabling a more cohesive and effective delivery of digital education across educational institutions, thus enhancing digital skills and competences for the digital transformation and creating a high-performing digital education ecosystem in the partners countries at first (Greece, Cyprus, Germany, Portugal, Poland) and in Europe on second stage.

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1.2 The deliverable

Current deliverable **"D2.2 Framework for Data literacy skills in Education"** is part of **"WP2 Analysis and Identification of best practices"** and more specific, belongs to the task **"T2.2 Development of a framework for Data Literacy Skills in Compulsory Education"** (Figure 1).

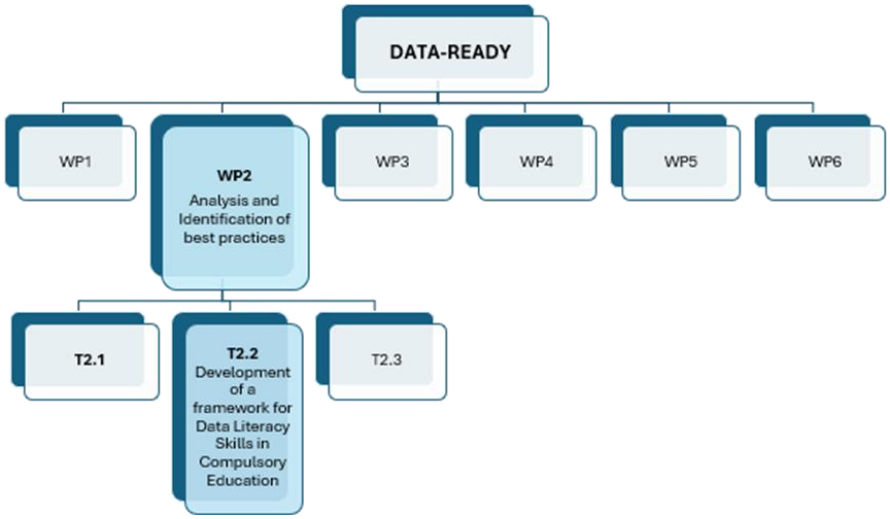

Figure 1. DATA-READY Work packages and Tasks

Key objectives of WP2 are the following:

- Conduct comprehensive research on DL strategies in compulsory education across partner countries.
- Identify and document the various approaches, policies, and practices currently in place.
- Identify gaps and areas for improvement in current DL education, providing a basis for further development.
- Develop and validate a standardized framework that defines key DL skills and competencies for teachers.

The primary objective of T2.2 is to develop a comprehensive and standardized framework for data literacy skills in compulsory education. This framework will serve as a guideline for educators and policymakers to effectively integrate data literacy into the curriculum, ensuring that students acquire essential data-related competencies.

In this context, the primary objective of D2.2 is to create a comprehensive, standardized framework that outlines essential data literacy skills for students in compulsory education. This framework will guide educators and policymakers in integrating data literacy into the curriculum, ensuring that students develop the necessary competencies to navigate and utilize data effectively. The framework will provide a structured approach to data literacy education, detailing key domains, competencies, proficiency levels, and implementation guidelines.

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Key components of the deliverable are:

- Core Competencies and Skills that students need to develop to achieve data literacy.
- Proficiency levels for each competency, providing clear progression paths for students.
- Descriptors and Performance Indicators.
- Guidelines for implementing the framework in educational settings.
- Supporting Elements for Educators.
- Training and Professional Development.
- Evaluation Methods.
- Governance, review measures, and recommendations.

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2 Purpose

The Data Literacy Competence Framework for Compulsory Education sets out a shared vision for how students in primary and lower secondary education can progressively build the knowledge, skills, and dispositions needed to participate effectively in a data-driven world. Its aim is to ensure that all learners leave school able to engage critically and responsibly with data, whether in everyday life, further study, or future work. In this Framework, competence refers to an integrated combination of knowledge, skills, and dispositions demonstrated in the context of data-informed inquiry.

The Framework is grounded in both theory and practice. It draws on international research in education and digital competence, including the European Commission's DigCompEdu framework (Redecker 2017), the OECD Learning Compass 2030, UNESCO's Media and Information Literacy guidance, and recent theoretical work such as Data Literacy: The Essential Language in the Digital Era (Law & Yim, 2025). It also reflects developments in the emerging field of Educational Data Literacy, particularly the framework proposed by Papamitsiou et al. (2021), which highlights the ethical, analytical, and application dimensions of data use for education professionals. Together, these perspectives emphasise that data literacy is not only a technical skillset but also a social and ethical competence shaped by critical thinking, creativity, communication, and responsible agency.

Alongside this theoretical foundation, the Framework reflects the analysis of curricula, policy documents, and classroom practices carried out across partner countries in the DATA READY project (DATA READY 2025). This dual grounding ensures that the Framework is not an abstract proposal, but a realistic and evidence-based tool for schools.

A key feature of the Framework is its integration of ethical, technical, and social dimensions of data use. Students are supported not only to handle data accurately and effectively but also to understand its impact on society, to recognise issues of privacy and bias, and to use data as a means of participation and agency.

The Framework builds directly on the findings of earlier project work (DATA READY 2025), which identified both the urgent need for coherent approaches to data literacy in compulsory education and the opportunities for embedding it across existing subjects and cross-curricular activities. Yet, embedding new competences within established curricular structures poses significant challenges. Integrating transversal areas such as data literacy often requires teachers to reinterpret subject goals, develop interdisciplinary collaboration, and balance innovation with curricular constraints. Similar tensions have been observed in efforts to integrate other cross-cutting competences such as digital competence (DigCompEdu), media and information literacy (UNESCO, 2021), and sustainability education (OECD Learning Compass 2030), suggesting that while the challenge is not unique, it demands careful systemic coordination. Against this background, the Framework offers a structured yet flexible approach: by defining clear domains, progression pathways, and examples for practice, it aims to make data literacy both visible and achievable within the realities of classroom teaching and curriculum design.

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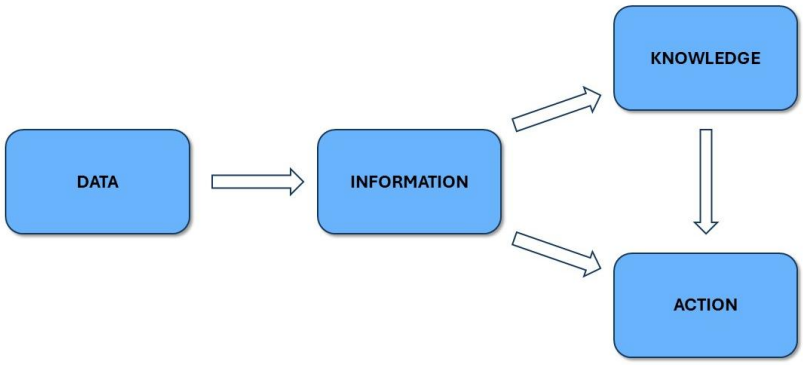

Figure 2 Data transformation flow

In this Framework, *data* is understood as raw records, observations, or digital traces that acquire meaning only when they are organised and interpreted within a context. *Information* is data placed in context. This understanding aligns with the logic of the OECD Learning Compass 2030, which emphasises the transformation of data into knowledge and action through reflection, ethics, and agency, and with DigCompEdu, which situates data use within the broader concept of digital competence. By adopting this perspective, the Framework recognises that data are not neutral or self-explanatory: they are collected, curated, and used within social, cultural, and ethical frameworks.

Data may take many forms, including numerical, textual, visual, audio, or observational records, and may originate from primary sources (such as direct measurements or surveys) or secondary sources (such as existing databases, reports, or digital platforms). Regardless of format or origin, the Framework treats these diverse forms as potential inputs for inquiry and interpretation, emphasising that data literacy involves understanding how different types of data are generated, structured, and used within specific contexts.

In educational contexts, it is also useful to distinguish between **learning about and from data** and **learning with data**. Learning *about and from data* refers to the development of data literacy competences themselves such as collectingstudents, analysing, interpreting, and critically evaluating data. Learning *with data*, in contrast, refers to the use of data as a resource to support learning in other subject areas (e.g., understanding scientific phenomena, social trends, or economic processes). The Framework recognises both perspectives, while focusing primarily on the competences required for meaningful engagement with data across subjects.

Developing data literacy therefore involves not only the ability to handle and interpret data but also the critical capacity to question their origins, purposes, and implications in human and digital systems. **The identification of key domains in the next section builds on this understanding, translating it into a structured competence model that supports progression from early exploration of data to informed, responsible, and creative engagement.**

2.1 Evidence base from DATA READY D2.1 (2025)

2.1.1 Role of DATA READY D2.1 (2025) for the Framework

Deliverable **DATA READY D2.1 (2025)** consolidates conceptual definitions, related literacies, and country evidence across the partnership and is the primary knowledge base that our

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Framework translates into school-ready domains, progression bands, and proficiency levels. It documents converging definitions of data literacy (DL), core competence components, and persistent implementation gaps (policy, curriculum, and teacher PD), which this Framework addresses through a coherent structure for grades 1–9.

2.1.2 Conceptual foundations

DATA READY D2.1 (2025) synthesises DL as a cross-disciplinary competence that enables people to ask and answer real-world questions with data, ethically and critically linking collection, analysis, interpretation, and communication, and extending to action. Representative definitions include Ridsdale et al. (inquiry with ethical use, skills from selection to storytelling), the Data Quality Campaign (collect, manage, evaluate, apply), and Mandinach & Gummer (transforming information into actionable knowledge for decisions). These converge on DL as more than technique: it is evidence-based reasoning embedded in authentic contexts.

DATA READY D2.1 (2025) also positions DL within wider competency ecosystems: scientific literacy, digital literacy, and AI education. This emphasises evaluation of evidence, methods, bias, and responsible use. UNESCO's AI curriculum is cited to underscore ethics, privacy, and bias awareness as integral to DL, not optional add-ons.

Literacy	Focus	Key skills	Purpose
Data literacy	quantitative and qualitative data, datasets, statistics, visualizations	collecting, analyzing, interpreting, modelling and communicating data	making informed, data-driven decisions and understanding evidence based on data
Digital literacy	digital technologies, online platforms, and digital environments	using digital tools, managing digital content, communicating and collaborating online	functioning effectively and safely in digital environments
Information literacy	information sources such as books, articles, databases, and websites	searching, selecting, evaluating credibility, and using information ethically	identifying and using reliable information for learning or problem solving
Scientific literacy	scientific concepts, theories, and empirical evidence	understanding scientific methods, interpreting research results, and evaluating scientific claims	understanding scientific phenomena and making evidence-based judgments about scientific issues

2.1.3 Core competence components (as precursors to the seven domains)

Across sources, DATA READY D2.1 (2025) summarises four recurring DL components: **Data Collection, Analysis, Interpretation, Communication** - which align directly with our domains (DA&M, A&I, R&V/C&A) and are complemented in our model by **Awareness, Ethics & Agency**, **Questioning & Problem Framing**, and **Modelling & Automation** to capture inquiry, values, and computational procedures.

- **Collection / Management** → *DA&M*: understanding sources, methods, recording, organisation, and quality.

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- **Analysis / Interpretation** → *A&I* and *R&V*: statistical/analytical techniques, reading patterns, representing uncertainty.
- **Communication / Action** → *C&A*: presenting findings for audiences and decisions; moving from evidence to action.
- **Ethics / Agency** (emphasised by UNESCO Media and Information Literacy & policy discourse) → *AE&A*: privacy, consent, bias, fairness.
- **Inquiry framing** → *Q&PF*: from investigable questions to variables and constraints (echoed in Means et al.).
- **Automation / Modelling** → *M&A*: rules, algorithms, simulations; understanding how automated processes shape outcomes.

Connections to **DigCompEdu**: DATA READY D2.1 (2025) emphasises on protecting data, information handling, and civic-oriented communication resonates with DigCompEdu learner-facing areas (information & media literacy; communication & collaboration; management/protection of digital resources), which our C&A and AE&A domains translate into pupil competences for compulsory schooling.

2.1.4 Cross-cutting principles distilled in DATA READY D2.1 (2025)

- **Ethics and fairness**: DL requires explicit treatment of privacy, consent, bias, and fairness, both pedagogically and in policy.
- **Interdisciplinarity**: DL content appears across mathematics, science, ICT, social studies, and civics; siloed approaches limit relevance.
- **From evidence to action**: Many DL definitions include planning, acting, and evaluating impact. Our C&A domain operationalises this.
- **Teacher capability**: Persistent gaps in teacher preparation, tools, and support necessitate practical exemplars and progression guidance (our bands/levels respond to this).

2.2 Policy and curriculum context (findings across countries)

DATA READY D2.1 (2025) finds **no explicit national DL policies** among the five studied countries; DL is typically fragmented across ICT/digital skills, mathematics, or media education. Strategic efforts exist but lack coherence; explicit DL naming, curricular alignment, and teacher training are recommended.

Country evidence (surveys, case studies) illustrates the opportunity space:

- **Cyprus**: civic/environmental data projects using official portals and citizen data highlight authentic, cross-subject DL but reveal limited systemic support.
- **Poland**: innovative school-level practices span copyright/privacy (early grades), project-based informatics, and geospatial mapping (ArcGIS) for local data demonstrating DA&M–R&V–C&A integration even without a formal DL policy.

Summarizing, DATA READY D2.1 (2025) calls for **systemic coordination** across curriculum, assessment, teacher PD, and infrastructure; and for embedding ethics and fairness to safeguard learners and improve interpretive quality. Our Framework's domains, progression bands (P1, P2,

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Lower Secondary), and proficiency levels (Starting – Intermediate – Advanced) provide the actionable structure to meet these needs in grades 1–9.

2.2.1 Methodology of development (Draft Stage)

The present draft of the **Data Literacy Competence Framework** reflects the first two stages of the methodology defined in the DATA READY project proposal (Work Package 2). Its development has followed a structured, evidence-based process combining theoretical synthesis with empirical mapping across partner countries.

Step 1 – Mapping and Analysis (Preparation Phase).

Between project months 1 and 6, partners conducted an extensive review of existing research, curricula, and national policies on data literacy and related competences. This work is documented in Deliverable DATA READY D2.1 (2025) (*Study of Data Literacy Strategies in Compulsory Education*), which consolidated conceptual definitions, related literacies, and country evidence. It identified core components of data literacy, implementation gaps, and priority needs in curriculum, assessment, and teacher professional development.

Step 2 – Framework Design and Drafting (Development Phase).

Building on DATA READY D2.1 (2025), partners collaboratively translated the analytical findings into a competence model suited to compulsory schooling. Through iterative workshops and online consultations, the partnership identified seven key domains, three progression bands (Primary 1, Primary 2, Lower Secondary), and three proficiency levels (Starting, Intermediate, Advanced). Existing international references (DigCompEdu, GAISE II, OECD Learning Compass 2030, UNESCO MIL Framework) were aligned and adapted to the school context of partner countries.

Step 3 – Initial Validation (Stakeholder Workshops).

The current version of the Framework incorporates feedback from **ten national validation workshops** conducted across the five partner countries (two per country). These workshops engaged teachers, policymakers, and experts to assess the clarity, relevance, and applicability of the Framework. Their feedback contributed to refining conceptual definitions, strengthening the transversal role of ethical and societal dimensions, clarifying domain boundaries, and improving usability for educational practice. This stage resulted in the present draft (working v.1), intended for experimentation and finalisation.

Next steps (Experimentation and Finalisation).

The subsequent stages will extend validation through activities in **WP3 (teacher training)** and **WP4 (classroom experimentation)**. These phases will generate further empirical insights, including evidence from classroom implementation and teacher professional development. The results will inform the final refinement of the Framework (Deliverable D2.2, Month 18), ensuring its robustness, usability, and transferability across educational contexts.

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3 Key domains

The identification of key domains in this Framework reflects both theoretical foundations and practical gaps observed in education. International research consistently stresses that data literacy is not a single skill but a process that spans from formulating questions through to interpreting results and taking informed action. Models such as the PPDAC cycle (Wild & Pfannkuch, 1999), the Data Investigation Process (Lee et al., 2022), and frameworks reviewed in recent studies (Papamitsiou et al., 2021; Witte et al., 2025) highlight the importance of covering the *entire cycle* of data engagement. This means addressing not only technical operations such as analysis and visualisation but also the often-overlooked stages of problem framing, ethical reflection, and communication.

Evidence from recent reviews of K-12 education (Witte et al., 2025) shows a significant imbalance: teaching practices tend to emphasise data analysis and interpretation, while the equally essential skills of asking meaningful questions, planning and conducting data collection, and managing data are less systematically developed. To address this imbalance, the present Framework defines seven domains that together capture the full breadth of data literacy as a competence for all students. These domains are designed to ensure that young people can not only work competently with data but also engage with it critically, ethically, and creatively across diverse contexts.

Based on our comprehensive study and analysis of existing models and practices, we have identified the following seven key domains that together form the core of data literacy in compulsory education:

1 **Awareness, Ethics & Agency (AE&A)** – privacy, bias, rights, and social use of data.

2 **Questioning & Problem Framing (Q&PF)** – posing data-driven questions.

3 **Data Acquisition & Management (DA&M)** – collecting, cleaning, storing data.

4 **Representation & Visualisation (R&V)** – tables, graphs, maps, digital displays.

5 **Analysis & Interpretation (A&I)** – reasoning with data, recognizing patterns, uncertainty.

6 **Modelling & Automation (M&A)** – using algorithms, spreadsheets, simulations.

7 **Communication & Action (C&A)** – reporting, storytelling, applying data to decisions.

The seven domains presented here build on and extend a wide body of earlier work on data literacy. Foundational models emphasized dimensions such as accessing, interpreting, and using data for decision-making (Means et al., 2011; Marsh, 2012; Ridsdale et al., 2015), as well as ethical and critical engagement (Prado & Marzal, 2013; Wolff et al., 2016). Frameworks developed for educators highlighted the role of pedagogical knowledge and reflection in transforming data into actionable knowledge (Mandinach & Gummer, 2013, 2016).

Taken together, these contributions underline that data literacy involves not only technical skills but also the capacity to pose meaningful questions, to curate and preserve data responsibly, and to evaluate the outcomes of decisions informed by data. The present Framework synthesizes these insights while adapting them to the needs of compulsory education, ensuring that all students develop a broad, balanced, and future-oriented competence profile.

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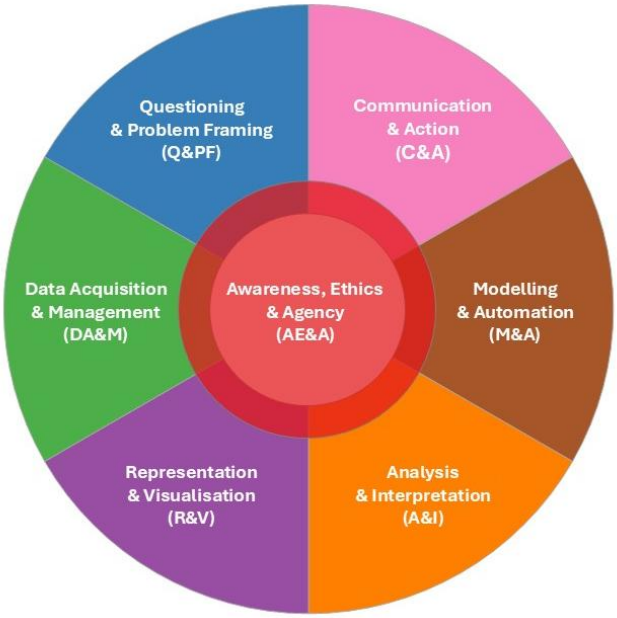

Figure 3. Data Literacy Framework Domains

The seven domains are also aligned with international standards and initiatives such as the European Commission's DigCompEdu (Redecker, 2017), the American Statistical Association's GAISE II guidelines for PreK – 12 (Bargagliotti et al., 2020), and UNESCO's Media and Information Literacy curriculum (UNESCO, 2021). At the same time, they go beyond these models by giving greater emphasis to ethical agency, interdisciplinary integration, and learner reflection, areas that are increasingly recognised as crucial for education in a data saturated society.

Although the Framework presents seven distinct domains, these should not be interpreted as strictly sequential stages or isolated skill sets. In classroom practice, work with data typically involves several domains simultaneously, as learners move iteratively between posing questions, collecting and representing data, interpreting results, and communicating conclusions. Some domains - such as Questioning & Problem Framing, Data Acquisition & Management, basic Representation & Visualisation, and Analysis & Interpretation - often serve as common entry points for classroom activities and are therefore expected to appear frequently across subjects and grade levels. Other domains, including Modelling & Automation, may emerge more prominently in specific disciplines or in more advanced learning situations. Nevertheless, all seven domains remain integral components of the data literacy process and may appear at different levels of complexity depending on age, subject context, and pedagogical design.

The domain **Awareness, Ethics & Agency (AE&A)** is presented as a distinct domain because ethical reflection and responsible decision-making constitute essential competences. At the same time, ethical considerations accompany every stage of data work. For example, when learners formulate questions they may consider whether the question could reinforce stereotypes; during data acquisition they may address issues such as privacy, consent, and data reliability; in analysis and representation they may reflect on bias, uncertainty, or misleading visualizations; and when communicating results they may consider the social consequences of data-based claims. In this sense, AE&A functions both as a dedicated competence area and as a transversal perspective informing the responsible use of data across all other domains.

It should also be noted that the order in which domains appear in the Framework does not prescribe a fixed teaching sequence. In practice, data literacy is rarely taught as a standalone

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subject and instead emerges within different disciplines such as mathematics, science, social studies, or digital education. Consequently, the entry point into the data literacy process may vary depending on the subject, the pedagogical approach, and the learning context. Rather than following a linear progression through the domains, learners typically engage in a **spiral and iterative process**, repeatedly moving between questioning, collecting data, representing results, interpreting evidence, and communicating conclusions. This flexibility is particularly important in international contexts, where curricula and institutional structures differ substantially across education systems.

3.1 Awareness, Ethics & Agency (AE&A)

This domain develops students' understanding of the social and ethical dimensions of data. From the earliest years, learners begin to notice that some information is personal and requires protection. By the end of the lower secondary school, students are expected to recognise issues of bias, privacy, consent, and ownership, and to evaluate how data influences decision-making in society. The goal is to foster not only technical skills but also a sense of agency and responsibility, enabling young people to act as informed citizens who can protect their own data and critically examine the practices of others. In this context, AE&E becomes particularly important, as the use of automated and AI-driven data processes raises new ethical, societal, and epistemic challenges.

Evidence base: DATA READY D2.1 (2025) shows that ethical and civic dimensions are integral to data literacy, not optional add-ons. Conceptual definitions consistently link DL to recognising bias and critically evaluating information and relate it to digital literacy through shared concerns about privacy, cybersecurity, and ethical use of dataDa[2]. System-level evidence from focus groups highlights strong ethical concerns among stakeholders about security, privacy, governance, misuse, and bias in educational data, and calls for human-centred, rights-based data governance and learner agency[3]. Survey and interview data further document gaps in teachers' confidence and preparation around legal and ethical aspects of data use (privacy, consent, fairness, bias), underscoring the need to foreground these issues in compulsory education[4]. These findings underpin AE&A as a domain that combines protection of personal data, critical scrutiny of data practices, and students' capacity to act as responsible, empowered citizens.

Associated competencies

By the end of Grade 9, students should be able to:

- **AE&A1.** Distinguish between personal, shared, and public data and explain why some data should be protected.
- **AE&A2.** Identify examples of bias or unfairness in how data are collected, presented, or used.

[2] D2.1, conceptual definitions and related literacies (ethical use, recognizing biases, critical evaluation; privacy, cybersecurity, ethical considerations in data use), Ch. 3, pp. 31–33.
[3] D2.1, focus group synthesis (DL as composite competence including ethical and pedagogically sound use; links to civic responsibility and digital citizenship; ethical concerns about security, privacy, misuse, bias, and rights-based data governance), §7.4.6 Summary, pp. 258–259.
[4] D2.1, teacher survey and interview evidence (recognition of ethical issues—fairness, consent, bias, responsible use; uncertainty about legal frameworks; concerns about consent, cross-border risks, algorithmic suggestions, and stigmatization), selected items in Ch. 6–7, pp. 145–146, 180–181.

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- **AE&A3.** Explain basic principles of data consent, privacy, and ownership in everyday digital contexts (e.g., social media, surveys, apps).
- **AE&A4.** Describe the potential social impact of data-based decisions and propose ways to make them more fair or transparent.
- **AE&A5.** Demonstrate responsible data behaviour in school projects—seeking permission, anonymising data, and acknowledging sources.
- **AE&A6.** Reflect on their own role as data producers and users, recognising both rights and responsibilities in digital environments.

3.2 Questioning & Problem Framing (Q&PF)

This domain develops students' ability to formulate meaningful, data-informed questions and to understand what kinds of data are required to investigate them. In the early years, learners begin by asking simple factual questions about familiar phenomena or curiosity-driven questions such as "Which fruit do we like most in class?" They observe that different questions require different kinds of information. As they gain experience, they learn to distinguish between questions that can be answered through observation, measurement, or simple data collection, and those that require external sources or broader context. By the end of lower secondary education, students are expected to pose investigable questions, articulate the purpose of an inquiry, identify relevant variables, and anticipate the type of data or evidence needed to answer their questions. The goal is to support learners in framing purposeful, data-driven investigations that guide analysis and deepen understanding across subjects. This progression ensures that learners view data not as isolated numbers, but as a tool to explore and solve real problems.

Evidence base: DATA READY D2.1 (2025) identifies question posing and problem definition as core components of data literacy across conceptual models. The deliverable shows that widely cited DL definitions explicitly include *formulating questions*, identifying *information needs*, and using data to support evidence-based inquiry, with sources such as Vahey et al. (2006) and Means et al. (2011) describing DL as the ability to "formulate and answer questions using data" and to engage in structured question posing as an essential part of data work[5]. Curriculum analyses in the report highlight that national systems often emphasise data analysis but provide comparatively weak support for helping learners develop investigable questions or link questions to appropriate evidence, which creates a gap between data handling and purposeful inquiry[6]. System-level and country evidence further show that teachers and stakeholders view data literacy as inherently tied to *problem solving* and *real-world investigation*, calling for stronger support for students in clarifying questions, refining problems, and designing inquiries that require gathering and interpreting evidence[7]. These findings underscore Q&PF as a foundational domain in which learners develop the ability to frame meaningful, data-informed inquiries that guide interpretation, reasoning, and action.

Associated competencies

By the end of Grade 9, students should be able to:

[5] D2.1, conceptual definitions and DL components (including question posing, identifying information needs, inquiry orientation), Ch. 3, pp. 30–33.
[6] D2.1, review of national curricula and DL components (limited emphasis on inquiry framing; gaps in linking questions to evidence), Ch. 3 summary & Ch. 6 synthesis, pp. 30–33 and pp. 145–146.
[7] D2.1, country evidence & stakeholder perspectives (DL as problem-solving; need for support in question formulation and inquiry design), focus group synthesis §7.4.6, pp. 258–259.

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- **Q&PF1.** Pose clear, testable questions that can be answered using data, distinguishing between factual, opinion-based, and investigable questions.
- **Q&PF2.** Identify what information or data are needed to answer a question and suggest how such data could be collected.
- **Q&PF3.** Define measurable variables and anticipate how they may relate to one another (e.g., cause–effect, comparison, or correlation).
- **Q&PF4.** Recognise the limits of available data and propose refinements or new questions when data are insufficient or ambiguous.
- **Q&PF5.** Connect data questions to real-world contexts, explaining why the question matters and who might use the findings.
- **Q&PF6.** Work collaboratively to refine a question into a small, feasible classroom or community investigation, recognising ethical and practical constraints.

3.3 Data Acquisition & Management (DA&M)

Here the focus is on the processes of collecting, recording, storing, and managing data. At the foundation stage, children engage in simple activities such as counting, tallying, or sorting items. Later, they begin to design surveys, measure quantities, and record information systematically. By the time they reach secondary school, students are introduced to sampling strategies, data cleaning, and digital organisation, including awareness of secure storage and backup practices. Ultimately, this domain equips students with the capacity to design and manage a small-scale data pipeline, paying attention to quality, accuracy, and security at every stage.

Evidence base: DATA READY D2.1 (2025) identifies data collection, recording, and management as central components of data literacy across conceptual frameworks. DL definitions reviewed in Chapter 3 consistently emphasise *data gathering*, *data location*, *data comprehension*, and the ability to judge the *reliability* and *adequacy* of data sources, including skills such as documenting sources and recognising limitations[8]. Curriculum analyses across the five partner countries show that while students commonly learn to handle data in mathematics and science, far less attention is given to evaluating source quality, managing data systematically, or understanding issues such as sampling and data completeness. All of which competences are recognised gaps in current practice[9]. Country-level survey and interview evidence further highlights widespread concerns about data accuracy, data quality, and data management practices, including teachers' uncertainty about validating sources, ensuring data completeness, and using digital tools for storage and organisation[10]. These findings collectively position DA&M as a core domain that strengthens learners' capacity to gather and manage data responsibly across contexts.

Associated competencies

[8] D2.1, conceptual definitions and DL components (data gathering; data location; data comprehension; evaluating sufficiency and reliability), Ch. 3, pp. 30–33.
[9] D2.1, review of national curricula (data handling taught but source evaluation and data quality rarely addressed; limited focus on sampling or documentation of sources), synthesis in Ch. 5 & Ch. 6, pp. 142–147.
[10] D2.1, country evidence from surveys and interviews (concerns about accuracy, completeness, reliability, and digital management of data), stakeholder perspectives in §7.4.6 and related pages, pp. 252–259.

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By the end of Grade 9, students should be able to:

- **DA&M1.** Plan and carry out simple methods for collecting data through observation, measurement, or survey, using appropriate tools.
- **DA&M2.** Record data systematically using tables, tally marks, or digital forms, ensuring clarity and consistency.
- **DA&M3.** Distinguish between different types of data (categorical, numerical, continuous) and choose suitable recording formats.
- **DA&M4.** Apply basic sampling principles—such as fairness, representativeness, and avoiding duplication—when collecting data.
- **DA&M5.** Detect and correct obvious errors or inconsistencies in collected data, explaining why data quality matters.
- **DA&M6.** Organise and store datasets in digital environments (e.g., spreadsheets, shared drives) with attention to security, privacy, and backup.
- **DA&M7.** Reflect on the data collection process, discussing how choices about what and how to collect can influence results and interpretation.

3.4 Representation & Visualisation (R&V)

This domain develops the ability to choose, construct, and interpret visual and numerical representations of data. In the early years, students work with pictographs and simple tables that match their everyday experiences. As their education progresses, they encounter a wider range of representations, including bar charts, line graphs, and pie charts, learning how each can highlight different aspects of a dataset. In secondary school, they compare more sophisticated visualisations such as boxplots, histograms, or scatterplots, and they learn to critique misleading displays. By the final stages of their compulsory education following the present Competence Framework, learners are expected to design effective, multi-layered visualisations, making deliberate choices to reveal patterns, relationships, and uncertainty for different audiences.

Evidence base: DATA READY D2.1 (2025) shows that visual representation and interpretation are central components of data literacy across conceptual models and curricular practices. Definitions reviewed in Chapter 3 highlight *representing and interpreting data* as core processes within statistical and media literacy, noting that graphical interpretation is essential for evidence-based reasoning[11]. Curriculum analyses across partner countries emphasise that visualisation is frequently taught in mathematics and science, yet students often lack opportunities to compare representations, critique the clarity or accuracy of displays, or understand how visual decisions shape meaning. These areas are flagged as gaps in current provision[12]. Case studies and national reports further underscore the importance of teaching students to interpret and critique visualisations found in news media, where graphs are widely used and can easily mislead; D2.1 documents the potential of media-based tasks to strengthen students' critical

[11] D2.1, conceptual definitions and DL components (representing data; interpreting data; graphical interpretation as part of statistical and media literacy), Ch. 3, pp. 30–33.
[12] D2.1, review of national curricula (importance of visualisation; gaps in comparing representations or detecting misleading design; emphasis on mathematics/science graphs), national curriculum extracts, pp. 326–327.

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graphical interpretation skills and visual literacy[13]. All these findings support R&V as a domain that equips students to create, interpret, and critically evaluate visual representations of data in both school and everyday environments.

Associated competencies

By the end of Grade 9, students should be able to:

- **R&V1.** Read and interpret simple data representations such as pictographs, tally charts, and basic tables, linking them to real-world contexts.
- **R&V2.** Create clear and accurate visual displays (bar, line, and pie charts) using collected or provided data, choosing suitable scales and labels.
- **R&V3.** Compare how different types of graphs or tables can emphasise particular aspects of the same dataset.
- **R&V4.** Identify and explain common sources of misrepresentation in charts or graphics (e.g., distorted scales, selective categories).
- **R&V5.** Construct and interpret more advanced visualisations such as histograms, boxplots, or scatterplots using digital tools where appropriate.
- **R&V6.** Annotate visualisations to communicate meaning effectively, highlighting trends, outliers, or uncertainty.
- **R&V7.** Critically evaluate visual representations found in media or online sources, distinguishing between accurate, biased, and manipulative displays.

3.5 Analysis & Interpretation (A&I)

This domain develops students' ability to examine data, identify patterns, and draw reasoned conclusions. At primary level, this may mean simple observations such as identifying what is "most" or "least." As students advance, they calculate and interpret measures such as mean, median, and mode, and begin to describe variability in data. In lower secondary, learners extend these skills by using percentages, rates, and simple correlations, and they start to reason about error and sampling. Beyond calculation, this domain also nurtures *statistical thinking*, i.e. the ability to connect data patterns to real contexts, to consider uncertainty, and to draw reasonable conclusions. The domain builds steadily towards the capacity to use evidence critically and responsibly in decision-making.

Evidence base: DATA READY D2.1 (2025) highlights analysis and interpretation as central components of data literacy across conceptual definitions, identifying them as core processes that enable individuals to make sense of data, recognise patterns, and draw evidence-based conclusions. Definitions reviewed in Chapter 3 consistently emphasise *reading*, *interpreting*, and *analysing* data as key elements of DL, directly linked to critical evaluation and decision-making[14]. Curriculum analyses across partner countries show that while students frequently learn to work with graphs, tables, and simple statistics, they are less often guided to interpret patterns critically, explain variability, or consider limitations such as uncertainty and sampling. These

[13] D2.1, country case studies (media-based graph interpretation tasks; developing critical reading of visualisations; potential of news graphics for statistical literacy), case studies in Portugal, pp. 343–348.
[14] D2.1, conceptual definitions and DL components (data analysis; data interpretation; reading and evaluating evidence; recognising patterns), Ch. 3, pp. 30–33.

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areas are identified as underdeveloped in current practice[15]. Case studies in D2.1 provide further evidence that learners benefit from structured opportunities to interpret real-world datasets, compare patterns, and articulate explanations: for example, students analysing EUROSTAT population data or exploring geometric patterns using digital tools were able to progress from simple reading of values to more complex contextual interpretation and generalisation[16]. Taken together, these findings establish A&I as a domain that strengthens learners' capacity for meaningful data reasoning and critical interpretation.

Associated competencies

By the end of Grade 9, students should be able to:

- **A&I1.** Describe data patterns in everyday terms (e.g., most/least, higher/lower, increasing/decreasing).
- **A&I2.** Calculate and interpret basic summary measures (mean, median, mode) and recognise what each tells about the dataset.
- **A&I3.** Identify and explain variation within data, using range or simple visual cues (e.g., spread of bars or scatter points).
- **A&I4.** Use proportions, percentages, and rates to compare groups or trends, linking results to practical contexts.
- **A&I5.** Recognise the concept of sampling and explain how sample size or method might influence conclusions.
- **A&I6.** Identify possible sources of error or uncertainty in data and suggest ways to reduce or account for them.
- **A&I7.** Draw and justify conclusions based on evidence, clearly distinguishing between correlation and causation.
- **A&I8.** Reflect on how personal bias, selective attention, or incomplete data can affect interpretation and judgement.

3.6 Modelling & Automation (M&A)

This domain addresses the use of rules, algorithms, and digital tools to extend what can be done with data. In the early years, children follow step-by-step instructions to sort or classify information, often in unplugged or playful activities. Later, they begin to use simple spreadsheet formulas or calculators to transform and combine data. In lower secondary, students design small-scale simulations and digital experiments, using randomness or algorithms to explore possible outcomes and test ideas. This domain develops both *computational and analytical thinking,* helping learners understand how patterns and rules can represent real situations, and how automated procedures can make data work more efficiently and consistently. It prepares young people to engage with an increasingly automated world where algorithms shape decisions and everyday experiences. In this domain, learners engage with modelling and automation in ways that increasingly involve generative AI and automated data processes, requiring them to

[15] D2.1, review of national curricula (frequent emphasis on graph reading and basic statistics; limited attention to uncertainty, variation, or explaining patterns), national curriculum extracts, pp. 326–327.
[16] D2.1, case studies (interpretation of EUROSTAT population tables; identifying numeric and geometric patterns using structured inquiry and digital tools), Case 2 & Case 3 descriptions, pp. 54–56.

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understand not only how models are constructed but also how algorithmic systems generate and shape outputs.

Evidence base: DATA READY D2.1 (2025) identifies modelling, algorithms, and automation as important extensions of data literacy, stressing that data competence increasingly involves understanding how automated processes transform and generate data. Conceptual definitions reviewed in Chapter 3 include constructing models, following and creating rules, and using algorithms as key elements of computational and statistical reasoning that support inquiry and evidence-based decision-making[17]. Curriculum analyses across partner countries show that modelling and automation receive limited explicit emphasis in compulsory schooling, despite increasing expectations for students to use spreadsheets, coding tools, and rule-based processes to manipulate and analyse data. This imbalance is noted as a system-wide gap[18]. Case studies included in D2.1 demonstrate that when students engage with digital tools to automate calculations, explore parameter changes, or reason about algorithmic decisions, they develop deeper understanding of patterns, dependencies, and the limitations of automated systems, reinforcing the importance of embedding modelling and automation within DL instruction[19]. These findings establish M&A as a domain that enables learners to work with and think critically about the computational structures through which contemporary data practices operate.

Associated competencies

By the end of Grade 9, students should be able to:

- **M&A1.** Follow and explain simple step-by-step procedures (algorithms) for sorting, counting, or classifying information.
- **M&A2.** Use calculators or digital tools to perform repetitive or multi-step operations accurately.
- **M&A3.** Apply basic formulas in spreadsheets or similar tools to organise, transform, and summarise data.
- **M&A4.** Recognise and describe simple patterns or relationships that can be expressed as rules or models.
- **M&A5.** Use digital simulations or random experiments to explore variability, chance, and prediction.
- **M&A6.** Modify given rules or procedures to test “what if” scenarios, interpreting the changes in outputs.
- **M&A7.** Explain in simple terms how algorithms or automated processes influence everyday decisions (e.g., recommendations, sorting, or grading).
- **M&A8.** Reflect on the benefits and limitations of automation, including fairness, transparency, and human oversight.

[17] D2.1, conceptual definitions and DL components (modelling, rules, algorithms as part of computational–statistical reasoning), Ch. 3, pp. 30–33.
[18] D2.1, review of national curricula (limited emphasis on modelling/automation; gaps in spreadsheet use, coding, and algorithmic reasoning), curriculum synthesis and examples, pp. 142–147.
[19] D2.1, case studies (students using spreadsheets or digital tools to automate calculations, explore parameter changes, and interpret algorithmic behaviour), case examples in Portugal and Poland, pp. 343–348.

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3.7 Communication & Action (C&A)

The final domain focuses on how data is transformed into knowledge that can guide communication and decision-making. From the earliest years, children learn to express findings in words, pointing to evidence in a chart or table. As their skills grow, they move beyond description to structured explanations that connect claims, evidence, and reasoning. In secondary school, students are introduced to tailoring their communication to different audiences, making choices about language, format, and medium to maximize clarity and impact.

Building on earlier frameworks (e.g., Means et al., 2011; Marsh, 2012; Mandinach & Gummer, 2016), this domain also emphasizes the use of data as the basis for *informed action*. Students learn not only to present results but also to recommend actions, weigh alternatives, and justify decisions in light of evidence. Importantly, they are encouraged to evaluate the outcomes of these actions – to ask whether decisions taken were effective, fair, and ethical, and what could be improved in future cycles of inquiry. By the final stage of compulsory education, learners are expected to produce evidence-based reports or briefs that integrate analysis, reflection, and recommendations, while acknowledging limitations and ethical considerations.

The overarching aim of this domain is to prepare students to act as responsible and reflective citizens in a data saturated society: able to engage in dialogue, influence decisions, and adapt their actions based on the effectiveness and consequences of prior decisions.

Evidence base: DATA READY D2.1 (2025) identifies communication and action as essential components of data literacy across conceptual models, with multiple definitions highlighting *storytelling*, *presentation*, and *evidence-based decision-making* as key outcomes of data work[20]. The deliverable shows that curriculum documents across partner countries consistently emphasise students' ability to *communicate findings*, *justify conclusions*, and *present evidence clearly*, yet provide fewer opportunities for learners to use data in authentic decision-making or civic contexts: an identified gap in current practice[21]. Case studies within D2.1 illustrate that when students engage in tasks such as reporting survey results, interpreting media graphics, or discussing socio-environmental issues using local datasets, they not only learn to communicate more effectively but also begin to apply data in reflective and socially meaningful ways[22]. These findings support C&A as a domain that bridges data analysis with informed action, empowering learners to use data purposefully in communication, collaboration, and civic participation.

Associated competencies

By the end of Grade 9, students should be able to:

- **C&A1.** Describe information derived from data clearly in spoken or written form, referring to specific evidence (e.g., tables, graphs).
- **C&A2.** Construct simple explanations linking claims and evidence, using appropriate reasoning or comparison.

[20] D2.1, conceptual definitions and DL components (communication, storytelling, argumentation, evidence-based decision-making), Ch. 3, pp. 30–33.
[21] D2.1, national curriculum review (focus on presenting results; gaps in applying data for action or informed decisions), curriculum extracts in Ch. 6, pp. 142–147.
[22] D2.1, case studies (students reporting findings, interpreting media graphs, applying data to socio-environmental issues; development of civic engagement through data use), country case examples, pp. 343–348.

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- **C&A3.** Select suitable formats and media (oral, visual, digital) to communicate results effectively to a target audience.
- **C&A4.** Summarise key insights from data and propose possible actions or decisions based on the evidence.
- **C&A5.** Discuss different interpretations of the same data and explain how perspective or context can influence conclusions.
- **C&A6.** Collaborate in presenting data findings, integrating text, visuals, and argument into a coherent group report or presentation.
- **C&A7.** Reflect on the consequences of data-informed decisions, evaluating whether they were effective, fair, and ethical.
- **C&A8.** Demonstrate civic responsibility by using data to participate in discussions or initiatives that address community or environmental issues.

Together, the seven domains form a coherent and cyclical process of data engagement: from recognising ethical and social dimensions to asking questions, collecting and analysing data, modelling patterns, and communicating results for action. Each domain reinforces the others: ethical awareness guides responsible collection, clear questioning drives meaningful analysis, and effective communication transforms insight into informed decision-making. Viewed as a whole, the Framework positions data literacy not as a set of isolated skills but as an integrated process of inquiry, reflection, and responsible participation that supports learners in understanding and shaping the data-saturated world around them.

3.8 Cross-cutting themes

- Tool Fluency and Digital Confidence

  A key theme across all domains is the gradual and inclusive development of tool fluency. At primary level, this may mean using physical objects, tally marks, or simple pictographs to engage with data. As students move forward, they are introduced to digital tools such as spreadsheets, calculators, and simple visualisation software. The emphasis is not on mastering particular programs but on building transferable skills and a positive, adaptable relationship with technology.

- Collaboration and Communication

  Data work is rarely a solitary activity. Students learn to collaborate in posing questions, designing surveys, and analysing results, with each member contributing different strengths. This collaborative approach reflects how data is used in real-world contexts, where teamwork and negotiation are essential. Communication is not limited to formal reporting; it includes everyday dialogue in the classroom, peer feedback, and presenting results in ways that respect different perspectives.

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- Inclusivity and Accessibility

Ensuring that every student can participate meaningfully is a guiding principle of the Framework. Data examples are drawn from contexts that reflect the diversity of students' lives and cultures. Teachers are encouraged to provide multiple entry points into tasks, for instance through storytelling, visual supports, or hands-on activities. Attention is given to avoiding exclusion in datasets themselves, so learners can recognise how data practices may reinforce or challenge stereotypes and inequalities.

- Metacognition and Reflection

Metacognition and reflection are essential for turning data use into thoughtful practice. At each stage of education, students are encouraged to consider not only *how* they worked with data but also *why* they made particular choices and what impact those choices had. For example, they might reflect on why a bar chart was selected instead of a line graph, or why one sample produced more reliable results than another.

In line with calls from earlier frameworks (e.g., Marsh, 2012; Ridsdale et al., 2015; Mandinach & Gummer, 2016), this theme also stresses the importance of evaluating the *effectiveness of actions taken based on data*. Students are guided to ask: Did the decision we made, supported by data, actually improve the situation? Were there unintended consequences? What can we learn for next time? By making reflection a systematic part of the cycle, learners develop the habit of treating data literacy not as a one-off activity but as a continuous, adaptive process.

Finally, students are supported in developing an awareness of their own thinking and learning about data. At each stage, they are encouraged to reflect on questions such as: *How did I choose this representation? What makes my conclusion convincing? What are the limitations of my data?* By making reflection explicit, the Framework helps learners not only acquire technical skills but also become thoughtful, critical users of data.

3.9 Alignment with DigCompEdu and UNESCO Media and Information Literacy (MIL)

To ensure coherence with major international standards and support transferability across educational systems, the Framework is aligned with established reference models for digital and information competences. The seven domains build directly on the European Commission's DigCompEdu framework and UNESCO's Media and Information Literacy (MIL) competencies, both of which emphasise critical, responsible, and participatory use of digital information.

From DigCompEdu, the Framework draws particularly on learner-facing areas such as Information and Media Literacy, Digital Resources, Assessment, and Facilitating Learners' Digital Competence. These areas inform our focus on ethical data practices, critical evaluation, and effective communication. The DATA READY domains translate these broad constructs into concrete competences for data-rich inquiry in compulsory education.

UNESCO's MIL framework contributes the societal and civic dimensions of information use. This influence is reflected in the domains of Awareness, Ethics & Agency, critical engagement with representations, and the ability to use evidence for informed action. While media literacy traditionally centres on information, the Framework foregrounds **data** (the raw material from which information is derived) as the foundation for understanding, decision-making, and participation.

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Together, these connections show that the Framework is consistent with major international standards while offering a specialised, developmentally appropriate model for data literacy in primary and lower secondary education. The following subsection provides a focused mapping of these points of alignment.

Mapping Table: DATA READY → DigCompEdu → UNESCO MIL

The table below shows how each of the seven DATA READY domains corresponds to elements of DigCompEdu[23] and UNESCO MIL. *(Note: Alignment is conceptual, not one-to-one.)*

Table 1. Cross-framework Alignment of Data Literacy Competence Domains.

DATA READY Domain	Corresponding DigCompEdu Areas	Corresponding UNESCO MIL Competences	Notes on Alignment
1. Awareness, Ethics & Agency (AE&A)	- Area 1: Professional Engagement (ethical digital use) - Area 6: Facilitating Learners' Digital Competence (responsible use, wellbeing, safety)	- Understanding ethical issues - Rights, privacy, security - Media & information ethics	Strong alignment on privacy, consent, bias, fairness, and agency. AE&A extends MIL to include the ethics of data collection, algorithmic influence, and datafication.
2. Questioning & Problem Framing (Q&PF)	- Area 3: Teaching & Learning (designing learning activities)	- Information needs identification - Inquiry and critical questioning	Q&PF operationalises inquiry-based learning: defining investigable questions, identifying needed data, and connecting data to real-world contexts.
3. Data Acquisition & Management (DA&M)	- Area 2: Digital Resources (creating, organising, managing content)	- Accessing and retrieving information - Organising and storing information	Clear alignment with resource handling and information organisation. DA&M extends MIL into structured data pipelines, sampling, and data quality.
4. Representation & Visualisation (R&V)	- Area 2: Digital Resources (managing formats) - Area 6: Learners' Digital Competence (information & media literacy)	- Interpretation of information - Understanding media representations	R&V deepens the MIL focus on representation by emphasising statistical and graphical literacy and identifying misleading visuals.
5. Analysis & Interpretation (A&I)	- Area 4: Assessment (analysing evidence, interpreting data)	- Critical evaluation of information - Analysis and synthesis	A&I corresponds directly to DigCompEdu's evidence-based reasoning and MIL's critical evaluation competencies.
6. Modelling & Automation (M&A)	- Area 2: Digital Resources (creating/modifying) - Area 3: Teaching & Learning (exploring new formats)	- Understanding digital technologies - Evaluating information systems	M&A adds computational aspects (rules, algorithms, simulations) that extend both frameworks into areas linked to AI literacy and computational thinking.
7. Communication & Action (C&A)	- Area 1: Professional Engagement - Area 4: Assessment (feedback and planning) - Area 6: Communication & Collaboration	- Communication for participation - Knowledge creation - Civic engagement through information	C&A aligns strongly with MIL's civic participation elements. It emphasises using data to communicate, justify decisions, and support informed action.

[23] Note: DigCompEdu Area 5 (Empowering Learners) has no direct one-to-one correspondence with a single DATA READY domain. Its focus on inclusion, differentiation, and active engagement underpins several domains indirectly, but it is not itself a data literacy competence. For this reason, Area 5 is not represented by individual mappings in the table or diagram.

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A visual overview of this alignment is provided in the diagram below, summarising the relationships between the DATA READY domains and the corresponding areas in DigCompEdu and UNESCO MIL.

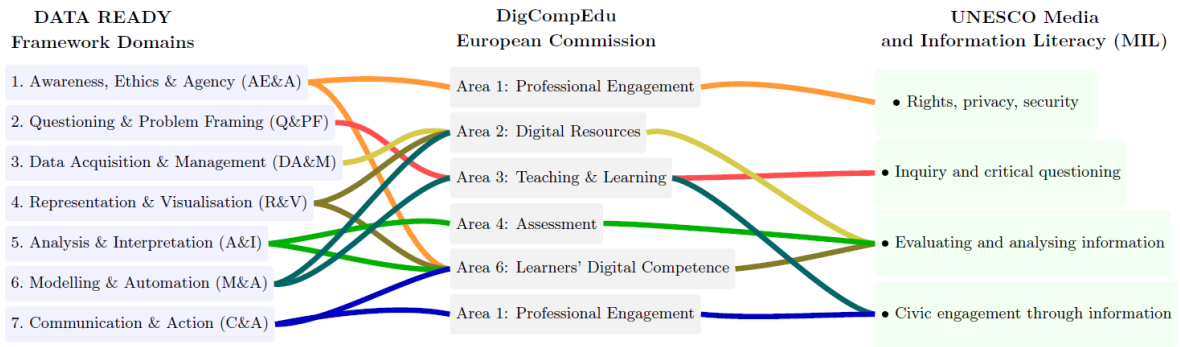

Figure 4. Relationships between the DATA READY domains and the corresponding areas in DigCompEdu and UNESCO MIL

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4 Progression Bands

The development of data literacy across compulsory education requires a structure that reflects typical stages of cognitive growth and curricular progression. For this reason, the Framework organises learning into **three progression bands**, each capturing the dominant developmental characteristics of learners in that phase. These bands apply across all seven domains and provide the foundation for the Descriptor Matrices that follow.

Foundations (Primary 1: Grades 1–3)

At this stage, learners begin to encounter data in simple, concrete forms. They engage in basic activities such as counting, sorting, and recording observations, gradually recognising that information can be represented and shared. Ethical awareness is introduced in an age-appropriate manner, centred on recognising personal information and acting safely when handling it. Across the domains, learning focuses on guided exploration, curiosity, and establishing the earliest building blocks for later data inquiry.

Developing (Primary 2: Grades 4–6)

Learners begin to work with data in more structured and systematic ways. They pose investigable questions, design simple data-collection approaches, construct common visual representations, and calculate basic summaries such as averages. Their ethical reasoning becomes more explicit, including awareness of fairness, simple forms of bias, and responsible behaviour in digital contexts. Data literacy becomes increasingly integrated across subjects, supporting learners in building fluency and confidence.

Expanding (Lower Secondary: Grades 7–9)

Learners deepen their competence into more complex reasoning, interpretation, and critique. They work with larger and more varied datasets, apply sampling principles, analyse variation, and interpret both graphical and numerical summaries with greater depth. Concepts such as correlation, uncertainty, and basic algorithmic processes are introduced in accessible forms. Ethical and societal dimensions become more pronounced, with learners evaluating privacy, bias, and the role of data in civic life. Communication becomes more purposeful, with learners beginning to justify interpretations and propose actions based on evidence.

Purpose of the Progression Bands

The progression bands serve to:

- ensure age-appropriate expectations across all domains;
- provide a coherent structure for multi-year curricular planning;
- guide the design of learning experiences that build cumulatively;
- complement the proficiency levels (Starting, Intermediate, Advanced) by distinguishing when learning typically develops from how well it is demonstrated.

Together, the progression bands and proficiency levels establish a dual structure that supports consistent, developmentally aligned implementation of the Framework.

5 Proficiency Levels

In addition to the three progression bands, which describe *when* learners typically develop particular aspects of data literacy, the Framework uses **three proficiency levels** to describe *how*

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well learners demonstrate these competences. These levels apply across all seven domains and enable teachers to observe, monitor, and support learners' growth within each progression band.

The proficiency levels reflect increasing independence, flexibility, and critical engagement with data. They are designed to be broad and descriptive, rather than prescriptive, ensuring they can be applied across diverse subjects, tasks, and learning contexts.

Starting

Learners at this level demonstrate emerging familiarity with the knowledge, skills, and behaviours within a given domain. They engage with data tasks with clear structure, guidance, and support. Their work typically focuses on recognising, recalling, or reproducing key ideas or procedures introduced during instruction. Understanding is concrete, and interpretations are closely tied to examples directly experienced in class. At this level, learners benefit from scaffolded activities and explicit modelling.

Intermediate

Learners begin to apply knowledge and skills with greater independence and consistency. They can carry out routine tasks, select familiar methods, and offer basic interpretations or explanations supported by evidence. They show growing awareness of the choices involved in data work such as selecting representations, identifying simple patterns, or considering fairness or accuracy. Their reasoning becomes more deliberate, and they can adapt approaches to fit the demands of familiar contexts or questions.

Advanced

Learners show flexible, confident, and critical use of data knowledge and skills. They can adapt methods appropriately, justify decisions, evaluate limitations, and reflect on sources of error, bias, or uncertainty. Their interpretations are thoughtful and grounded in evidence, and they can communicate findings for different audiences and purposes. At this level, learners may propose or refine their own approaches, connect insights across domains, and demonstrate responsibility and ethical awareness in data-related decisions.

Purpose of Proficiency Levels

The proficiency levels serve to:

- describe observable patterns of performance within each progression band;
- support formative assessment and differentiated instruction;
- help learners recognise their own growth and identify next steps;
- ensure that learning expectations remain flexible and responsive to diverse classroom contexts.

Together, the proficiency levels and progression bands offer a clear, developmentally aligned structure that supports coherent planning, meaningful assessment, and consistent implementation of data literacy across years and subjects.

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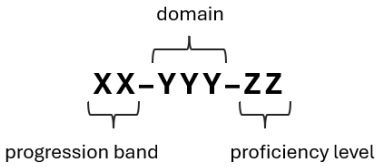
6 Descriptors

The descriptors translate the Framework's domains, progression bands, and proficiency levels into clear and concrete learning expectations. They illustrate how learners typically demonstrate data literacy competences as they move from *Foundations* to *Developing* and *Expanding*, and from *Starting* to *Advanced* levels of proficiency within each band.

Each descriptor presents integrated statements that combine knowledge, skills, and attitudes in age-appropriate ways. They are not intended as prescriptive checklists or assessment rubrics; rather, they provide a shared reference point to support curriculum design, lesson planning, and coherent progression across subjects and years. The descriptors help teachers understand what increasingly sophisticated engagement with data looks like in practice and offer schools a flexible tool for shaping meaningful learning experiences.

Together, the descriptors form the operational core of the Framework, enabling its domains to be enacted in classrooms while allowing space for adaptation to national curricula, local priorities, and diverse learner needs.

The descriptor codes used in this framework (e.g., P1–DA&M–L1) indicate the alignment between progression stages, competence domains, and levels of proficiency. Each code combines a progression band (e.g., Primary 1), a domain of data literacy (e.g., Data Acquisition & Management), and a proficiency level (from L1 to L3).



A later development phase of the Framework will expand each descriptor into explicit Knowledge, Skills, and Attitudes (K–S–A) learning outcomes to support teacher training and curriculum design.

6.1 Primary 1 (Grades 1–3) – Foundations

Awareness, Ethics & Agency (AE&A)

- **P1-AE&A-L1:** Student recognises that some information (e.g., name, photo) is personal and should be kept private.
- **P1-AE&A-L2:** Student can give examples of personal data and explain simple ways to protect it, such as asking before sharing.
- **P1-AE&A-L3:** Student explains why privacy matters and can describe how to act responsibly when using or sharing information.

Questioning & Problem Framing (Q&PF)

- **P1-Q&PF-L1:** Student poses simple questions about familiar topics (e.g., "Which fruit do we like best?").
- **P1-Q&PF-L2:** Student suggests what information is needed to answer a question and how it could be collected.

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- **P1-Q&PF-L3:** Student refines a question to make it measurable and predicts what kind of data might be useful.

Data Acquisition & Management (DA&M)

- **P1-DA&M-L1:** Student counts or sorts objects and records results using marks or pictures.
- **P1-DA&M-L2:** Student collects data systematically (e.g., tallying classmates' preferences) and records it in a table.
- **P1-DA&M-L3:** Student checks collected data for completeness or simple mistakes and explains how to keep records organised.

Representation & Visualisation (R&V)

- **P1-R&V-L1:** Student reads simple pictographs or tables showing familiar objects or class data.
- **P1-R&V-L2:** Student creates a pictograph or bar chart from collected data and labels it correctly.
- **P1-R&V-L3:** Student compares two visual displays and explains which shows the information more clearly.

Analysis & Interpretation (A&I)

- **P1-A&I-L1:** Student points out what happens "most" or "least" in a data display.
- **P1-A&I-L2:** Student describes simple patterns or differences in data and begins to use words like "more" or "fewer."
- **P1-A&I-L3:** Student uses data to answer a question, explaining what the results show about the group or situation.

Modelling & Automation (M&A)

- **P1-M&A-L1:** Student follows step-by-step instructions to sort or group information.
- **P1-M&A-L2:** Student describes a simple rule or sequence (e.g., "If it's red, put it here; if not, there").
- **P1-M&A-L3:** Student creates or modifies a simple rule to solve a problem or classify new information.

Communication & Action (C&A)

- **P1-C&A-L1:** Student says or shows what they found, pointing to a chart or table as evidence.
- **P1-C&A-L2:** Student writes or tells a short explanation linking results to the original question.
- **P1-C&A-L3:** Student shares findings with others, using clear language or visuals and suggesting what the results mean.

6.2 Primary 2 (Grades 4–6) – Developing

Awareness, Ethics & Agency (AE&A)

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- **P2-AE&A-L1:** Student identifies personal data in everyday contexts (e.g., forms, photos, online profiles).
- **P2-AE&A-L2:** Student explains why some data should be protected and follows agreed class rules for safe data use.
- **P2-AE&A-L3:** Student recognises examples of bias or unfairness in data displays and suggests how to make data collection fairer.

Questioning & Problem Framing (Q&PF)

- **P2-Q&PF-L1:** Student asks specific, measurable questions that can be answered with data (e.g., "How many students walk to school?").
- **P2-Q&PF-L2:** Student identifies variables to measure and suggests simple ways to collect information.
- **P2-Q&PF-L3:** Student refines questions to compare groups or explore relationships (e.g., "Do older students read more than younger ones?").

Data Acquisition & Management (DA&M)

- **P2-DA&M-L1:** Student collects data carefully using simple surveys, measurements, or observations.
- **P2-DA&M-L2:** Student organises data in a table or spreadsheet and checks for missing or repeated entries.
- **P2-DA&M-L3:** Student applies basic sampling ideas (e.g., asking a fair group) and explains how accurate data improves conclusions.

Representation & Visualisation (R&V)

- **P2-R&V-L1:** Student creates bar and line charts from collected data using correct labels and scales.
- **P2-R&V-L2:** Student chooses an appropriate graph type for given data and explains what it shows.
- **P2-R&V-L3:** Student compares two different graphs or tables of the same data and evaluates which is clearer or more accurate.

Analysis & Interpretation (A&I)

- **P2-A&I-L1:** Student finds simple patterns in data, such as increases, decreases, or clusters.
- **P2-A&I-L2:** Student calculates averages (mean, median, mode) and uses them to describe data.
- **P2-A&I-L3:** Student interprets results using percentages or rates and begins to discuss possible reasons for observed trends.

Modelling & Automation (M&A)

- **P2-M&A-L1:** Student uses spreadsheet functions or calculators to perform basic calculations.

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- **P2-M&A-L2:** Student creates simple formulas or rules to automate repetitive steps in data handling.
- **P2-M&A-L3:** Student modifies formulas or uses simple digital tools to explore "what if" changes and predict possible results.

Communication & Action (C&A)

- **P2-C&A-L1:** Student presents data findings in written, oral, or visual form with clear evidence.
- **P2-C&A-L2:** Student explains results, connects them to the initial question, and suggests possible conclusions.
- **P2-C&A-L3:** Student discusses the meaning of results with peers, identifying what could be done differently or improved next time.

6.3 Lower Secondary (Grades 7–9) – Expanding

Awareness, Ethics & Agency (AE&A)

- **LS-AE&A-L1:** Student describes examples of personal and public data and recognises potential risks in sharing them online.
- **LS-AE&A-L2:** Student identifies bias, privacy, and consent issues in data collection or use and explains their importance.
- **LS-AE&A-L3:** Student evaluates real or simulated data practices for fairness and transparency and proposes responsible alternatives.

Questioning & Problem Framing (Q&PF)

- **LS-Q&PF-L1:** Student formulates clear, data-driven questions that can be tested through collection or analysis.
- **LS-Q&PF-L2:** Student defines measurable variables and explains how they relate to the question under investigation.
- **LS-Q&PF-L3:** Student designs an investigable question involving multiple variables or criteria and anticipates possible limitations of the data.

Data Acquisition & Management (DA&M)

- **LS-DA&M-L1:** Student conducts small-scale data collection using surveys, sensors, or online sources, following basic ethical guidelines.
- **LS-DA&M-L2:** Student applies sampling methods, records data digitally, and identifies incomplete or inconsistent entries.
- **LS-DA&M-L3:** Student plans a data workflow (from source to storage), justifies data choices, and ensures accuracy and security throughout.

Representation & Visualisation (R&V)

- **LS-R&V-L1:** Student constructs and interprets charts or graphs (e.g., bar, line, or pie) with appropriate scales and annotations.
- **LS-R&V-L2:** Student uses digital tools to create more complex visualisations such as histograms or scatterplots, describing trends and patterns.

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- **LS-R&V-L3:** Student designs multi-layered or comparative visualisations and critiques misleading or biased data presentations found in media.

Analysis & Interpretation (A&I)

- **LS-A&I-L1:** Student describes relationships and simple trends in data using everyday language.
- **LS-A&I-L2:** Student applies statistical measures (mean, range, percentage, correlation) to interpret findings and explain variability.
- **LS-A&I-L3:** Student draws evidence-based conclusions, distinguishes between correlation and causation, and discusses uncertainty and possible error sources.

Modelling & Automation (M&A)

- **LS-M&A-L1:** Student uses basic spreadsheet or coding tools to perform calculations and summarise data automatically.
- **LS-M&A-L2:** Student builds or modifies simple models or simulations to explore "what if" scenarios or predictions.
- **LS-M&A-L3:** Student analyses algorithmic or automated processes (e.g., recommendations, classifications) and discusses their advantages, risks, and biases.

Communication & Action (C&A)

- **LS-C&A-L1:** Student presents results in an organised format using text, visuals, or digital media to explain what the data show.
- **LS-C&A-L2:** Student prepares short, evidence-based reports or presentations, drawing clear conclusions from data.
- **LS-C&A-L3:** Student communicates data findings for a specific audience, proposes informed actions, and evaluates the fairness and impact of possible decisions.

6.4 Descriptor matrices

The Descriptor Matrices that follow present the same learning expectations in a structured, two-dimensional format, organised by progression band and proficiency level. This alternative layout is designed to support teachers and curriculum designers by making the developmental sequence and internal coherence of the competencies easier to interpret and apply in practice.

These matrices are not intended as assessment checklists or prescriptive curricular sequences. Instead, they provide a shared reference point to support curriculum design, lesson planning, and the alignment of teaching practices across subjects. By illustrating what increasingly sophisticated data literacy looks like in practice, they help schools and teachers integrate the Framework in a coherent and realistic way, reflecting both developmental considerations and classroom feasibility.

In the current draft, the Descriptor Matrices present each competence as an integrated set of knowledge, skills, and attitudes. This condensed format aligns with the objectives of the present development phase, which focuses on establishing a coherent structure of domains, progression bands, and proficiency levels. In the next phase of Framework we will expand each competence descriptor into ***explicit learning outcomes structured under Knowledge, Skills, and Attitudes (K–S–A)****.*

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Table 2. Primary 1 – Descriptor Matrix (Domains × Proficiency Levels).

Domain	Level 1 — Starting	Level 2 — Intermediate	Level 3 — Advanced
AE&A — Awareness, Ethics & Agency	Recognises that some data or information (e.g., name, photo) is personal and should be kept private.	Gives examples of personal data and explains simple ways to protect it (e.g., ask before sharing).	Explains why privacy matters and describes responsible sharing in everyday situations.
Q&PF — Questioning & Problem Framing	Poses simple, curiosity-driven questions about familiar topics.	Suggests what information is needed and how it could be collected.	Refines a question to make it measurable and predicts what data would help.
DA&M — Data Acquisition & Management	Counts/sorts objects; records results with marks or pictures.	Collects data systematically and records it in a simple table.	Checks data for completeness/mistakes and keeps records organised.
R&V — Representation & Visualisation	Reads simple pictographs or tables about class data.	Creates a pictograph or bar chart with correct labels.	Compares two displays and explains which is clearer and why.
A&I — Analysis & Interpretation	Points out what happens "most" or "least" in a display.	Describes simple patterns or differences using "more/fewer."	Uses data to answer a question and explains what the results show.
M&A — Modelling & Automation	Follows step-by-step instructions to sort or group information.	Describes a simple rule/sequence (e.g., "If it's red, put it here").	Creates or modifies a simple rule to classify new items or solve a problem.
C&A — Communication & Action	Says/shows findings, pointing to the chart/table as evidence.	Gives a short explanation linking results to the question.	Shares findings clearly (with visuals) and suggests what the results mean.

Table 3. Primary 2 (Grades 4–6) – Descriptor Matrix.

Domain	Level 1 — Starting	Level 2 — Intermediate	Level 3 — Advanced
AE&A — Awareness, Ethics & Agency	Identifies personal data in everyday contexts (forms, photos, profiles).	Explains why some data should be protected; follows class rules for safe data use.	Recognises bias/unfairness in displays and suggests fairer ways to collect data.
Q&PF — Questioning & Problem Framing	Asks specific, measurable questions answerable with data.	Identifies variables to measure and suggests simple ways to collect them.	Refines questions to compare groups or explore relationships.
DA&M — Data Acquisition & Management	Collects data carefully via surveys, measurements, or observations.	Organises data in a table/spreadsheet; checks for missing or duplicate entries.	Applies basic sampling ideas and explains how accuracy improves conclusions.
R&V — Representation & Visualisation	Creates bar/line charts with correct labels and sensible scales.	Chooses an appropriate graph type and explains what it shows.	Compares two representations of the same data and judges which is clearer/more accurate.
A&I — Analysis & Interpretation	Finds simple patterns (increase/decrease/clusters).	Calculates mean/median/mode and uses them to describe data.	Interprets with percentages/rates and discusses plausible reasons for trends.
M&A — Modelling & Automation	Uses calculator or spreadsheet functions for basic calculations.	Creates simple formulas/rules to automate repetitive steps.	Modifies formulas or uses simple tools to explore "what if"

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			changes and predict results.
C&A — Communication & Action	Presents findings with clear evidence (text/oral/visual).	Explains results, links them to the question, and suggests conclusions.	Discusses meaning with peers and identifies improvements for a future attempt.

Table 4. Lower Secondary (Grades 7–9) – Descriptor Matrix.

Domain	Level 1 — Starting	Level 2 — Intermediate	Level 3 — Advanced
AE&A — Awareness, Ethics & Agency	Describes personal vs public data and recognises sharing risks online.	Identifies bias, privacy, and consent issues and explains their importance.	Evaluates data practices for fairness/transparency and proposes responsible alternatives.
Q&PF — Questioning & Problem Framing	Formulates clear, data-driven questions testable via collection/analysis.	Defines measurable variables and explains how they relate to the question.	Designs an investigable question with multiple variables/criteria and anticipates limitations.
DA&M — Data Acquisition & Management	Conducts small-scale collection (surveys/sensors/online) using basic ethics.	Applies sampling methods; records digitally; flags incomplete/inconsistent entries.	Plans a workflow (source→storage), justifies choices, and ensures accuracy/security.
R&V — Representation & Visualisation	Constructs/interprets bar, line, or pie charts with appropriate scales/annotations.	Uses digital tools to create histograms or scatterplots; describes trends/patterns.	Designs multi-layered/comparative visuals and critiques misleading or biased graphics in media.
A&I — Analysis & Interpretation	Describes relationships and simple trends in everyday language.	Applies mean, range, percentage, correlation; explains variability.	Draws evidence-based conclusions; distinguishes correlation vs causation; discusses uncertainty/errors.
M&A — Modelling & Automation	Uses spreadsheet or basic coding tools to automate calculations/summaries.	Builds/modifies simple models or simulations for “what if” scenarios/predictions.	Analyses algorithmic processes (recommendations/classifications) and weighs benefits, risks, biases.
C&A — Communication & Action	Presents results clearly using text/visual/digital media to explain what data show.	Produces short, evidence-based reports/presentations with clear conclusions.	Communicates for a specific audience, proposes actions, and evaluates fairness and impact.

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Appendix: Framework Glossary

Accuracy. Degree to which data correctly describe the real-world phenomenon being measured. *Source:* GAISE II (2020); Wolff et al. (2016)

Algorithmic decisions. Decisions produced through algorithmic processes. *Source:* Alan Turing Institute (2023)

Algorithms. Step-by-step rules or procedures for solving a problem or transforming data. *Source:* D2.2 draft framework; DATA READY D2.1 (2025)

Annotations. Notes explaining data visuals. Source: Cairo (2016)

Anonymising data. Removing identifying information from datasets to protect privacy. *Source:* Alan Turing Institute (2023)

Automation. Delegating repetitive or rule-based operations to digital tools or programmed procedures. *Source:* DATA READY D2.1 (2025)

Backup. Creating copies of data to prevent loss. *Source:* Alan Turing Institute (2023)

Bias in data. Systematic distortion introduced through collection, representation, analysis, or interpretation. *Source:* Wolff et al. (2016); DATA READY D2.1 (2025)

Boxplots. Visual summaries of data distributions. *Source:* GAISE II (2020)

Charts. A general term for visual summaries of data designed to make patterns or comparisons visible. *Source:* GAISE II (2020)

Clusters. Groups of similar data points. *Source:* GAISE II (2020)

Communication of findings. Sharing results, interpretations, and limitations in oral, written, visual, or multimodal form. *Source:* GAISE II (2020)

Comparative visualisations. Visuals comparing datasets or variables. *Source:* Cairo 2016

Computational thinking. A problem-solving approach that uses decomposition, pattern recognition, abstraction, and algorithmic procedures. *Source:* DATA READY D2.1 (2025)

Consent. Permission given by individuals for their personal data to be collected and used. *Source:* UNESCO (2021); Alan Turing Institute (2023)

Correlation. A statistical association between two variables, without by itself proving causation. *Source:* GAISE II (2020)

Critical data literacy. The ability to question data sources, methods, representations, power relations, and implications, not just to use techniques. *Source:* Wolff et al. (2016); Prado & Marzal (2013)

Data accuracy. Extent to which stored or processed data correctly reflect real-world values. *Source:* Wolff et al. (2016); GAISE II (2020)

Data acquisition. Obtaining data through observation, measurement, survey, retrieval, or other collection procedures. *Source:* Lee et al. (2022); DATA READY D2.1 (2025)

Data analysis. Using statistical, logical, or computational procedures to examine data for patterns, differences, and relationships. *Source:* GAISE II (2020); Lee et al. (2022)

Data collection. Systematically gathering data to answer a question or document a phenomenon. *Source:* GAISE II (2020); Lee et al. (2022)

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Data communication. Presenting findings, methods, and implications from data in ways that others can understand and evaluate. *Source:* GAISE II (2020); DATA READY D2.1 (2025)

Data completeness. The extent to which data are complete, i.e., contain all required values and attributes for a given purpose. *Source:* Ridsdale et al. (2015); Wolff et al. (2016)

Data culture. A learning or organisational environment in which data are routinely used, discussed, and questioned in responsible ways. *Source:* DATA READY D2.1 (2025); Marsh (2012)

Data duplication. Repeated or redundant entries in a dataset. *Source:* Ridsdale et al. (2015); Wolff et al. (2016)

Data ethics. The principles and values governing what ought to happen when people use data and data systems. *Source:* UNESCO MIL (2021); Wolff et al. (2016)

Data interpretation. Explaining what results mean in relation to context, question, and evidence limits. *Source:* Wild & Pfannkuch (1999); GAISE II (2020)

Data literacy. The ability to ask, answer, evaluate, and communicate questions with data in ethical and context-aware ways; in this glossary it is treated as a cross-disciplinary competence rather than a narrow technical skill. *Source:* DATA READY D2.1 (2025); Ridsdale et al. (2015); Mandinach & Gummer (2013)

Data management. Organising, storing, documenting, and maintaining data so they remain usable, secure, and interpretable. *Source:* Wolff et al. (2016); DATA READY D2.1 (2025)

Data modelling. Creating simplified representations of phenomena, systems, or relationships to describe, explain, or predict with data. *Source:* OECD (2021); DATA READY D2.1 (2025)

Data organisation. Structuring data into coherent forms such as tables, files, or categories to support later use. *Source:* Wolff et al. (2016)

Data ownership. Recognition of rights and responsibilities concerning datasets. *Source:* DATA-READY D2.1 (2025)

Data pipeline. Sequence of data processing stages from collection to analysis. *Source:* Alan Turing Institute (2023)

Data privacy. Protection of personal information from inappropriate exposure, access, or sharing. *Source:* UNESCO MIL (2021)

Data processing. Transforming raw data through sorting, coding, computing, filtering, or summarising. *Source:* Wolff et al. (2016); DATA READY D2.1 (2025)

Data producers. Individuals or organisations generating data. *Source:* DATA-READY D2.1

Data protection. Legal, technical, and procedural measures used to safeguard data against misuse or loss. *Source:* UNESCO MIL (2021); DATA READY D2.1 (2025)

Data quality. The extent to which data are accurate, complete, consistent, timely, and fit for purpose. *Source:* Ridsdale et al. (2015); DATA READY D2.1 (2025)

Data representation. The organisation of data into forms such as tables, symbols, or graphics so they can be read and reasoned about. *Source:* GAISE II (2020)

Data sources. Origins from which data are obtained, such as observations, surveys, sensors, databases, or public portals. *Source:* DATA READY D2.1 (2025); Wolff et al. (2016)

Data storytelling. Communicating data through a structured narrative that links evidence, interpretation, and audience purpose. *Source:* Ridsdale et al. (2015); DATA READY D2.1 (2025)

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Data visualisation. The graphical display of data to reveal patterns, comparisons, trends, and uncertainty. *Source:* GAISE II (2020); Cairo (as cited in D2.2 draft context)

Data workflow. Processes through which data are collected, organised, prepared, analysed, and used within a data investigation cycle. *Source:* Wolff et al. (2016); Lee et al. (2022)

Dataset. A structured collection of related data values, records, or observations. *Source:* GAISE II (2020); Wolff et al. (2016)

Decision making with data. Selecting or recommending actions based on analysed evidence and explicit reasoning. *Source:* Mandinach & Gummer (2013, 2016); DATA READY D2.1 (2025)

Distorted scales. Manipulated axis scales that exaggerate patterns. *Source:* Cairo 2016

Equity of data. Ensuring data collection, analysis and use do not reinforce social inequalities. *Source:* OECD (2021); Alan Turing Institute (2023)

Error sources. Factors causing inaccuracies in data. *Source:* Wolff et al. (2016)

Fairness. Principle that data practices and algorithmic processes should not systematically disadvantage groups. *Source:* Alan Turing Institute (2023)

Graphical interpretation. Understanding information presented in charts or graphs. *Source:* GAISE II (2020)

Graphs. Visual displays that show values or relationships among variables, such as bar charts, line graphs, or scatterplots. *Source:* GAISE II (2020)

Histograms. Graphs representing frequency distributions. *Source:* GAISE II (2020)

Human oversight. Monitoring automated systems to ensure accountability. *Source:* Alan Turing Institute (2023)

Manipulative displays. Visualisations intentionally misleading viewers. *Source:* Cairo 2016

Measurement error. Difference between the measured value and the true value caused by limitations in measurement processes. *Source:* GAISE II (2020)

Misrepresentation. Distortion of data through misleading visuals. *Source:* Cairo 2016

Multi-layered visualisations. Complex graphics showing multiple variables. *Source:* Cairo 2016

Open data. Data made publicly accessible for use, reuse, and sharing, usually with minimal legal or technical barriers. *Source:* DATA READY D2.1 (2025)

Outputs. Results generated by automated data systems. *Source:* Alan Turing Institute (2023)

Patterns. Regularities, structures, or recurring features observed in data. *Source:* GAISE II (2020)

Personal data. Information relating to identifiable individuals. *Source:* UNESCO (2021)

Pictographs. Images representing quantities of data. *Source:* DATA-READY framework

Prediction. Forecasting outcomes using data models. *Source:* GAISE II (2020)

Primary data. Data collected first-hand for a specific purpose or investigation. *Source:* GAISE II (2020); Lee et al. (2022)

Public data. Data made available for public use. *Source:* DATA-READY D2.1

Rates. Ratios comparing quantities across populations or time. *Source:* GAISE II (2020)

Relationships. Associations or connections between variables, categories, or measures. *Source:* GAISE II (2020)

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Reports. Written presentation of data analysis results. *Source:* GAISE II (2020)

Representativeness. Extent to which data reflect the population being studied. *Source:* GAISE II (2020)

Research question. A focused, answerable question that directs what data are needed and how they should be analysed. *Source:* GAISE II (2020); Lee et al. (2022)

Responsible data use. Data use that is lawful, fair, transparent, context-sensitive, and attentive to harm. *Source:* UNESCO MIL (2021); DATA READY D2.1 (2025)

Sample size. Number of observations included in a dataset. *Source:* GAISE II (2020)

Sampling limitations. Constraints that arise when a sample does not fully represent the population being studied. *Source:* GAISE II (2020); Wild & Pfannkuch (1999)

Scales. Numeric ranges used to measure values in graphs. *Source:* GAISE II (2020)

Secondary data. Data originally collected by others and reused for a new question or purpose. *Source:* Wolff et al. (2016); DATA READY D2.1 (2025)

Secure storage. Protection of datasets against loss or misuse. *Source:* Alan Turing Institute (2023)

Selective categories. Use of incomplete categories that bias interpretation. *Source:* Cairo 2016

Shared data. Data distributed across groups or institutions. *Source:* DATA-READY D2.1

Source credibility. Extent to which a data source is trustworthy and reliable. *Source:* Wolff et al. (2016); DATA-READY D2.1

Source quality. Reliability and credibility of a data source. *Source:* Wolff et al. (2016)

Statistical thinking. A broader habit of mind that views data as arising from a process, attends to variation, and links context to analysis. *Source:* Wild & Pfannkuch (1999)

Tables. Arrangements of data in rows and columns that support recording, comparison, and retrieval. *Source:* GAISE II (2020)

Trends. General directions of change across time or ordered observations. *Source:* GAISE II (2020)

Uncertainty. Recognition that data and conclusions are limited, approximate, and open to revision. *Source:* Wild & Pfannkuch (1999); GAISE II (2020)

Validating sources. Checking trustworthiness of data sources. *Source:* Wolff et al. (2016)

Variability. The degree to which data values differ from one another. *Source:* GAISE II (2020); Wild & Pfannkuch (1999)

Variables. Characteristics or quantities that can vary and be described, measured, or compared in a dataset. *Source:* GAISE II (2020); Lee et al. (2022)

Visual literacy. Ability to interpret graphical representations of data. *Source:* Cairo 2016

What-if scenarios. Testing hypothetical conditions using models. *Source:* OECD (2021)

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