

DATA-READY

Empowering Education through Data Literacy
Integration in Compulsory Education



DATA
R E A D Y

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D2.3 Workshops for validation of the framework



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Executive Summary

The DATA-READY project seeks to strengthen Data Literacy (DL) in compulsory education by developing and validating a comprehensive **European Data Literacy Competence Framework**. Deliverable D2.3 presents the results of a cross-national validation process carried out in five partner countries (Greece, Cyprus, Germany, Portugal, and Poland).

In total, **157 teachers, policymakers, researchers, and education stakeholders** participated in structured workshops, offering detailed feedback on the Framework's structure, content, and practical applicability in real school contexts.

Across countries and professional groups, the Framework was widely recognized as conceptually strong, comprehensive, and well aligned with current European priorities in digital competence, AI literacy, and civic education. Participants appreciated its solid theoretical grounding and its clear organization around seven interconnected domains: *Awareness, Ethics & Agency, Questioning & Problem Framing, Data Acquisition & Management, Representation & Visualization, Analysis & Interpretation, Modelling & Automation and Communication & Action*.

Stakeholders confirmed that the overall **structure** is coherent and logically organized, and that it resonates with established international reference frameworks. At the same time, they proposed constructive refinements. These included reducing perceived overlaps between closely related domains, positioning Awareness, Ethics & Agency more explicitly as a transversal dimension influencing all areas of data work and clarifying the progression logic so that it reflects the cyclical, inquiry-based nature of classroom practice rather than a strictly linear pathway.

In terms of **content**, the Framework was considered highly relevant to emerging educational needs, including digital citizenship, AI-rich learning environments, and evidence-based reasoning. Participants valued its balanced integration of technical, ethical, and civic elements. Nevertheless, they identified areas for further improvement: *clearer developmental differentiation in technically demanding domains (especially Modelling & Automation), a more explicit distinction between foundational competences and more advanced ones, and greater clarity in descriptors to support measurable, curriculum-aligned outcomes*. **Teachers particularly emphasized that progression bands and proficiency levels should better reflect the diverse and non-linear development patterns observed in real classrooms.**

Regarding **applicability**, participants agreed that the Framework has strong transformative potential at classroom, institutional, and policy levels. It was seen as capable of supporting cross-curricular integration, strengthening teacher professional development, and informing broader curriculum reform and digital education strategies. However, **successful and sustainable implementation** will require targeted teacher training, practical exemplars, aligned assessment tools, institutional leadership, and policy-level endorsement. Concerns were also expressed about possible increases in **workload and inequities** in digital infrastructure if implementation is not adequately supported.

Despite differences among national contexts, the validation findings revealed substantial **convergence**. There was strong endorsement of the Framework's overall vision, shared recognition of ethics and agency as central components, common requests for clearer progression scaffolding and simplified domain relationships, and broad agreement that sustained teacher capacity-building is the key condition for success.

Overall, the validation process confirms that the DATA-READY Framework provides a strategically relevant and pedagogically sound foundation for embedding data literacy in compulsory education. The proposed refinements do not call for structural redesign, but rather for **greater**



clarity, coherence, and practical guidance, particularly in domain interconnections, progression pathways, and implementation support.

These improvements will inform the final optimization of the Framework and guide the next phases of experimentation, teacher training, and policy integration. Taken together, the cross-national findings demonstrate that the Framework holds strong potential to support a coherent European approach to Data Literacy, one that equips future citizens to engage with data critically, ethically, and confidently in an increasingly data-driven world.

Introduction

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 understand, collect, analyze, interpret, visualize, and communicate data effectively and ethically, is now considered a crucial component of overall literacy, the ability to derive meaningful information from data, is now considered a crucial component of overall literacy, alongside reading, writing, and numeracy skills. 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

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.

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.

The deliverable

Current deliverable “**D2.3 Workshops for validation of the framework**” is part of “**WP2 Analysis and Identification of best practices**” and more specific, belongs to the task “**T2.3 Validation of the Framework**” (Figure 1).

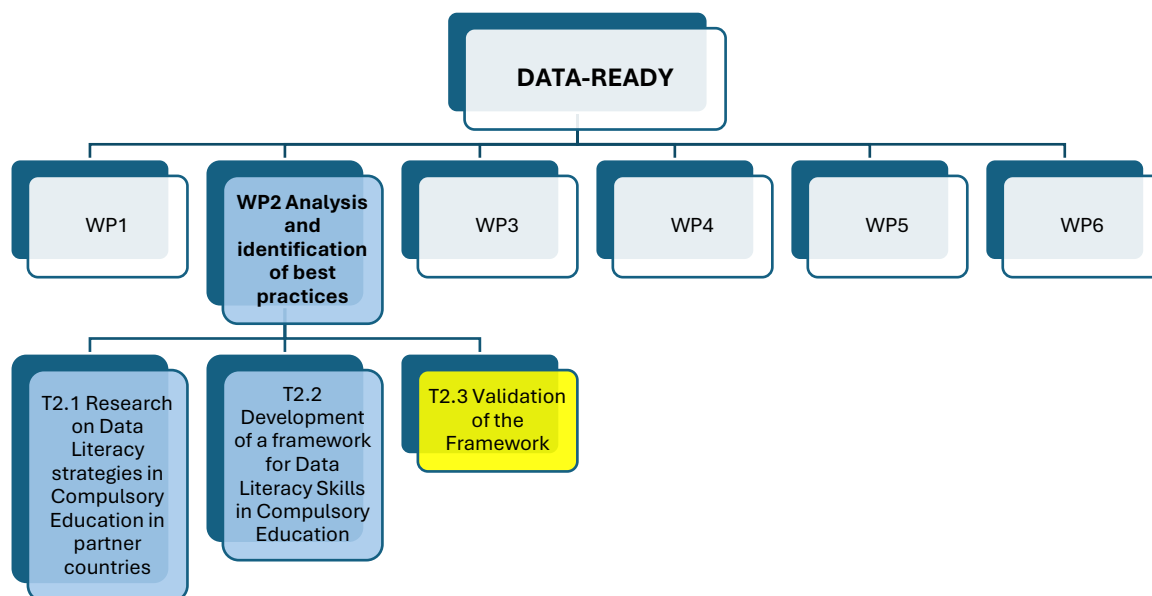


Figure 1 DATA-READY Work packages and Tasks

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 **T2.3 Validation of the Framework** was to provide a first validation of the developed framework for data literacy skills to ensure its effectiveness, relevance, and adaptability in various educational contexts within the partner countries. The validation was done through consultation workshops with stakeholders, including educators, policymakers, and subject matter experts, to gather feedback on the draft framework. The workshops were organized nationally; partners then used these data to revise the framework. The lead partner (AQAPSE) developed the methodology for the validation of the framework, which was used by partners during the implementation of the workshops. The proceedings of each workshop were documented, including key discussions, feedback received, and participant insights. A comprehensive report summarizing the key findings from the workshops was developed by country. The report highlights specific recommendations for revisions and enhancements to the framework based on participants' feedback.

In this context, the aim of **D2.3 Workshops for Validation of the Framework** was for 2 workshops to be organized in each country, aimed at validating the developed Framework for Data Literacy Skills in Education. These workshops gathered feedback from educators, policymakers, experts, and other stakeholders to ensure the framework is comprehensive, practical, and adaptable to various educational contexts. Participants did evaluate the framework's structure, content, and applicability, providing insights that will inform revisions. Each workshop had a duration of 1 day and at least 10 participants. The 1st workshop gathered feedback from teachers and the 2nd from policy makers and experts. The agenda was common for all partners, based on the methodology for validation developed in task T2.3.



Note: For GDPR purposes, screenshots from the workshops and lists of participants from each country are not presented here, as this report is public. The corresponding information is available for the project's reports.



The Data Literacy Framework (initial draft)

The initial draft of the framework which undergoes the validation process proposed seven interrelated domains that collectively define DL competence for students in compulsory education. This model builds upon and extends a substantial body of prior scholarship in the field of DL, synthesizing foundational insights while adapting them to contemporary educational contexts and mainly is based on the outcomes of the **D2.1 Study “Data literacy strategies in Compulsory education”**.

Earlier conceptualizations of DL emphasized core dimensions such as accessing, interpreting, and utilizing data for informed decision-making, alongside ethical and critical engagement with data sources and outputs. Subsequent frameworks developed specifically for educators further highlighted the essential role of pedagogical knowledge and reflective practice in transforming raw data into actionable knowledge. Collectively, these contributions established that DL encompasses not merely technical proficiency but also the capacity to formulate meaningful questions, to curate and preserve data responsibly, and to critically evaluate the outcomes of data-informed decisions.

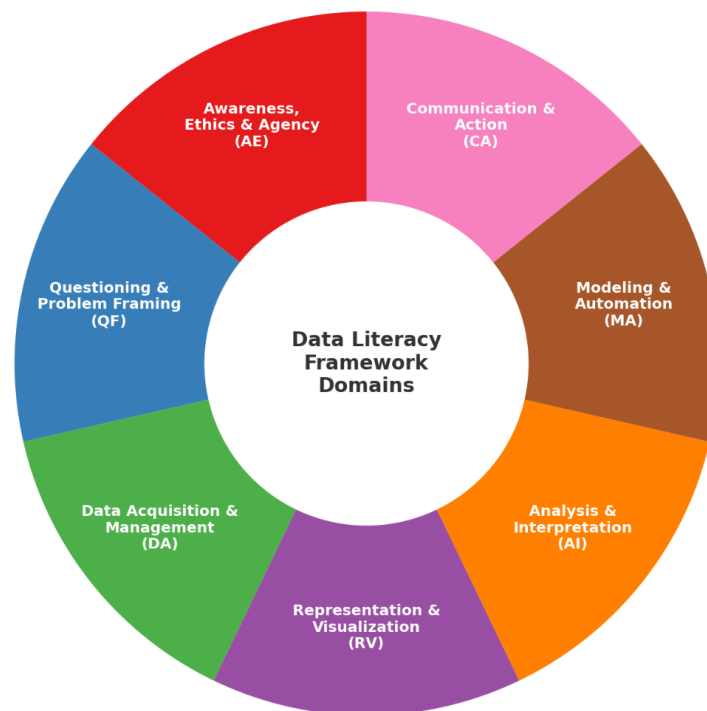


Figure 2 Data Literacy Framework Domains

The present Framework integrates these foundational insights while tailoring them to the specific requirements of compulsory education, thereby ensuring that all learners develop a comprehensive, balanced, and future-oriented competence profile. Furthermore, the seven domains are deliberately aligned with established international standards and initiatives in digital and statistical education, as well as media and information literacy curricula. Importantly, the Framework extends beyond existing models by placing heightened emphasis on three critical areas: ethical agency, interdisciplinary integration, and learner reflection. These dimensions are increasingly recognized as essential for preparing students to navigate and participate responsibly in a data-saturated society.

The present Framework identifies the following seven key domains that together form the core of DL in compulsory education:

1. Awareness, Ethics & Agency (AE) - privacy, bias, rights, and social use of data.
2. Questioning & Problem Framing (QF) - posing data-driven questions.
3. Data Acquisition & Management (DA) - collecting, cleaning, and storing data.
4. Representation & Visualisation (RV) - tables, graphs, maps, digital displays.
5. Analysis & Interpretation (AI) - reasoning with data, recognizing patterns, uncertainty.
6. Modelling & Automation (MA) - using algorithms, spreadsheets, simulations.
7. Communication & Action (CA) - reporting, storytelling, applying data to decisions.

The Descriptor Matrices presented hereafter display the same learning expectations in a structured, two-dimensional format, based on progression band and proficiency levels.

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

Domain	Level 1 - Starting	Level 2 - Intermediate	Level 3 - Advanced
Awareness, Ethics & Agency (AE)	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.
Questioning & Problem Framing (QF)	Poses simple, curiosity-driven questions about familiar topics.	Suggest what information is needed and how it could be collected.	Refines a question to make it measurable and predicts what data would help.
Data Acquisition & Management (DA)	Counts/sorts of 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.
Representation & Visualisation (RV)	Reads simple pictographs or tables about class data.	Creates a pictograph or bar chart with correct labels.	Compare two displays and explain which is clearer and why.
Analysis & Interpretation (AI)	Points out what happens “most” or “least” in a display.	Describes simple patterns or differences using “more/fewer.”	Use data to answer a question and explain what the results show.
Modelling & Automation (MA)	Follow 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.
Communication & Action (CA)	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.

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

Domain	Level 1 - Starting	Level 2 - Intermediate	Level 3 - Advanced
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Awareness, Ethics & Agency (AE)	Identifies personal data in everyday contexts (forms, photos, profiles).	Explains why some data should be protected; follows class rules for safe data use.	Recognizes bias/unfairness in displays and suggests fairer ways to collect data.
Questioning & Problem Framing (QF)	Asks specific, measurable questions answerable with data.	Identifies variables to measure and suggests simple ways to collect them.	Refine questions to compare groups or explore relationships.
Data Acquisition & Management (DA)	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.
Representation & Visualisation (RV)	Create 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 are clearer/more accurate.
Analysis & Interpretation (AI)	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.
Modelling & Automation (MA)	Use 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” changes and predict results.
Communication & Action (CA)	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.

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

Domain	Level 1 - Starting	Level 2 - Intermediate	Level 3 - Advanced
Awareness, Ethics & Agency (AE)	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.
Questioning & Problem Framing (QF)	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.

Data Acquisition & Management (DA)	Conducts small-scale collection (surveys / sensors / online) using basic ethics.	Applies sampling methods; records digitally; flags incomplete/inconsistent entries.	Plans a workflow (source → storage), justify choices, and ensures accuracy/security.
Representation & Visualisation (RV)	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.
Analysis & Interpretation (AI)	Describe 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.
Modelling & Automation (MA)	Use spreadsheets 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.
Communication & Action (CA)	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.

Methodology of the workshop

Introduction

In accordance with the Grant Agreement and the methodology outlined in Task T2.3 of the Erasmus+ DATA-READY project (ERASMUS-EDU-2024-POL-EXP), each project country organized two validation workshops. The purpose of these validation workshops is to assess and refine the Framework for Data Literacy Skills in Education.

The validation process tried to identify strengths, potential gaps, and opportunities for improvement, ensuring that the framework meets the needs of both practitioners and policymakers across partner countries.

The specific objectives of the validation process were to:

- Assess the relevance of the framework’s structure, domains, and competencies to the needs of teachers.
- Collect feedback on the effectiveness of the framework content.
- Evaluate the practical applicability of the framework in different national contexts.
- Identify missing elements and gather recommendations for improvement.
- Validate the coherence between the framework’s theoretical model and classroom realities in compulsory education.

The validation process was advanced through a methodological approach rooted in a content validation framework, which demonstrates that the items in an evaluation tool accurately and comprehensively reflect the intended content domain (Wilson et al., 2012).

Focusing on the evaluation items, Fitzpatrick (1983) identified four main distinct perspectives of content validity: (a) the clarity of the content domain, (b) the relevance of test content to that domain, (c) the adequacy with which the test content samples the domain, and (d) the technical quality of the items. He also identified two additional districts focused on the test responder, sampling adequacy of test responses, and relevance of test responses to a behavioral universe. These aspects of content validity reflect how well an instrument captures different facets of a construct (Rungtusanatham, 1998).

In addition to these principles, the validation methodology was aligned with the project’s Quality Assurance Framework established in Deliverable 2, which provides overarching criteria for ensuring rigor, coherence, and accountability throughout the development and evaluation process.

Specifically, the methodology integrates the Quality Assurance dimensions of:

- *Relevance*, ensuring that the framework and validation activities align with project goals, respond to stakeholder needs, and remain adaptable to diverse educational environments.
- *Coherence*, promoting compatibility between the framework and other national or institutional initiatives to guarantee complementarity and systemic alignment.
- *Effectiveness*, assessing the degree to which the framework supports the achievement of the project’s intended learning, pedagogical, and policy outcomes across different groups.
- *Efficiency*, ensuring that resources—human, methodological, and organizational—are used responsibly and in a timely manner during framework development and validation.

- Impact, considering the broader implications of the framework for teaching practice, decision-making, and long-term educational innovation, including both intended and unintended consequences.
- Sustainability, evaluating whether the framework can continue to deliver benefits beyond the project's duration and remain relevant for future policy and capacity-building initiatives.
- Ethical adherence, ensuring compliance with ethical guidelines, safeguarding participant well-being, and preventing conflicts of interest throughout the validation process.

By integrating both the psychometric foundations of content validity and the evaluative dimensions of the project's Quality Assurance Framework, the validation methodology achieves a dual focus: *it ensures the technical integrity of the Data Literacy Skills Framework while also aligning it with broader quality, relevance, and impact considerations essential for educational innovation.*

This comprehensive approach guarantees that the framework is not only conceptually well-established but also strategically aligned, contextually adaptable, and ethically grounded.

Workshop Structure

Workshop 1 (Teacher Validation)

The first validation workshop, titled **Teacher Validation**, was primarily dedicated to engaging teachers in an in-depth examination of the Data Literacy Framework. Its central aim was to collect structured, practice-oriented feedback from those who will ultimately apply and benefit from the framework within classroom and school contexts.

Participants explored how the proposed competencies align with their current pedagogical approaches, the realities of data use in their schools, and national curriculum expectations. Through guided discussions, teachers evaluated the extent to which the framework effectively supports data-informed decision-making, inclusive teaching, and continuous professional development. They critically examined the framework's relevance, effectiveness, and applicability within compulsory education settings.

The session also encouraged reflection on:

- The practical integration of data literacy concepts into existing teaching and assessment processes.
- The accessibility and clarity of competency descriptions and progression levels.
- The anticipated challenges and enablers for implementation within schools, and
- The capacity-building needs (e.g., resources, training, leadership support) are required for meaningful adoption.

Workshop 2 (Policymakers and Expert Validation)

The second validation workshop, entitled **Policy Makers and Expert Validation**, engaged stakeholders operating at the policy, research, and system-governance levels, including education ministry representatives, curriculum developers, inspectorate members, teacher training authorities, academics, educational researchers, and other key sectoral experts. Its overarching goal was to examine and validate the Data Literacy Framework from a strategic and systemic perspective.

This workshop focused on assessing the framework's coherence and alignment with existing educational strategies, digital transformation agendas, and national professional development activities for teachers. Participants evaluated whether the framework's domains and competencies reflected current policy objectives, such as digital competence frameworks,

sustainable learning goals, and evidence-based decision-making in education, and how these areas could be reinforced or made more consistent within national contexts.

Participants:

- Reviewed the structural logic and hierarchy of the framework and assessed its compatibility with national qualification or competence frameworks.
- Explored the policy implications of adopting such a framework across different education systems,
- Identified potential synergies and overlaps with other European or national initiatives in data literacy and digital education,
- Discussed implementation pathways, including teacher professional development policies, digital infrastructure requirements, and institutional governance mechanisms, and
- Provided strategic recommendations to enhance the framework’s feasibility, sustainability, and long-term impact.

The emphasis was on understanding how the framework could act as a policy instrument that supported the systemic integration of data literacy into teacher education, curriculum design, and digital education strategy. All insights generated were systematically documented through reporting Tables and National Reports, ensuring they capture the diversity of European education systems while remaining adaptable to National realities.

Overview of the Validation Workshops Process

Aspects	Description
Countries Involved	All project partner countries
Number of Workshops	Two per country (1 st : teachers; 2 nd : policymakers & experts)
Duration of each workshop	1-day event
Participants	Minimum of 10 participants per workshop
Methodology	Focus group discussion
Validation	Framework for Data Literacy Skills in Education

Workshop Preparation

- ✓ Each workshop included a minimum of **10 participants** who possess at least a basic understanding of, or expertise in, data literacy.
- ✓ Participant groups reflected diverse profiles, considering gender, professional affiliation, and areas of expertise.
- ✓ A standardized **invitation template** was provided to all partners and is included in the appendix.
- ✓ Before the workshop session, all participants were required to provide and sign the **informed consent form**, confirming their voluntary and informed participation in the workshop.
- ✓ Partners were able to adjust logistical aspects as needed, such as break times, equipment, and the choice of delivery format (face-to-face, hybrid, or fully online).
- ✓ The workshop duration was adjusted based on participant engagement and discussion depth.

- ✓ Discussions were facilitated using multiple methods and tools, such as presentations, guided discussions, breakout groups, and evaluation activities.
- ✓ All participants received the **Framework, along with an Executive Summary, in advance**, allowing them to study its content in depth.
- ✓ The thematic sections were consistent for all participants; however, certain questions have been adapted to reflect the specific perspectives of **teachers and policymakers**.

Workshop Implementation

Before the workshop

- Partners ensured that a device and appropriate software were available to record the audio in a teleconference system.
- Considering the complexity of the moderation role, it was recommended to assign two moderators to conduct the session: one responsible for leading the discussion and the other for managing supporting tasks, such as taking notes and ensuring that the audio is recorded.
- To collect the means of verification, it was also recommended to take photos of the session.

During the workshop

- Within the context of workshop implementation, focus group methodology was employed, engaging participants in guided discussions.
- The moderator was responsible for facilitating the discussion by presenting the framework to participants, reminding them of the validation questions, and eliciting their consensus regarding the framework.
- The moderator guided the workshop discussion effectively, incorporating additional comments beyond those provided in the Workshop Preparation Questionnaire, and ensuring in-depth, systematic feedback on the framework validation.

Below is a structured proposed agenda for the framework validation workshops, including timing, moderator guidance, and key discussion questions organized by core decision dimensions. It details opening and closing procedures, discussion probes, and moderator notes to ensure thorough feedback on the Framework.

The format is designed to capture both qualitative insights and practical suggestions from **teachers** and **policymakers**.

Workshop 1: Teachers (Classroom Perspective)

Opening & Framing

Moderator says:

Thank you for participating. Today we are validating a framework, not a curriculum or assessment tool. There are no right or wrong answers. We are interested in what is clear, what is challenging, and what would make this framework usable in real classrooms.

Ground rules (brief):

- Speak from experience
- Concrete examples are welcome
- Different views are valuable
- We aim for shared understanding, not agreement on everything

Discussion by Core Decision Dimensions

- Timing guideline: ~30 minutes per dimension.
- Use probes selectively if discussion stalls.

Closing Question

Ask everyone: If you could change **one thing** in the framework to make it more useful for teachers, what would it be?

Moderator's note: Capture each response verbatim if possible.

Wrap-up

- Thank participants.
- Explain next steps: synthesis - revisions - reporting (D2.3).
- Remind them to complete the post-workshop consensus survey.

1. Structural Clarity & Coherence

Q1. When you look at the framework, what feels **clear and usable** for you as a teacher, and what feels **complex or difficult to navigate**?

Q2. Do the domains, progression bands, and proficiency levels work together in a way that makes sense for classroom use, or are there points where the structure feels confusing?

Moderator asks: What feels clear and usable in the structure? What feels confusing or difficult to navigate?

Moderator probes: terminology, number of elements, navigation / readability

Moderator notes: Distinguish clarification needs from structural problems

2. Domain Completeness & Balance

Q3. Taken together, do the seven domains capture **what data literacy should realistically mean** for students in compulsory education?

Q4. Are any domains **overlapping, missing, or too dominant** compared to others from a teaching perspective?

Moderator asks: Do the seven domains capture what data literacy should mean for students? Are any domains overlapping, missing, or too dominant?

Moderator probes: questioning vs analysis, modelling & automation, ethics vs technical skills

Moderator notes: Ask for one concrete example if claims are abstract.

3. Progression Logic (Bands + Proficiency)

Q5. Does the progression from Primary 1 to Lower Secondary reflect how your students actually develop data-related skills over time?

Q6. Do the proficiency levels (Starting–Intermediate–Advanced) help you understand expectations, or do they risk being confusing or unrealistic?

Moderator asks: Does the progression reflect how students actually develop? Do proficiency levels help or confuse expectations?

Moderator probes: age appropriateness, pacing, classroom heterogeneity

Moderator notes: Watch for concerns about rigidity.

4. Classroom Applicability

Q7. If you were asked to start using this framework next school year, **where would you realistically begin?**

Q8. What aspects of the framework feel most *practically useful*, and which feel hardest to apply in everyday teaching?

Moderator asks: Where would you realistically start using this framework? What feels easiest and what feels hardest to apply?

Moderator probes: subject areas, lesson planning, assessment pressure

Moderator notes: Capture enablers and constraints separately.

5. Ethical Robustness & Equity

Q9. How confident would you feel using this framework to address issues such as **privacy, bias, fairness, and responsible data use** with your students?

Q10. Does the framework support inclusive practice for **diverse learners**, or are there areas where equity needs to be more explicit?

Moderator asks: How confident would you feel addressing privacy, bias, fairness with students? Is equity sufficiently visible?

Moderator probes: age-appropriate ethics, vulnerable learners

Moderator notes: Ethics often feels “important but abstract” – ask how it could be taught.

6. Adoption & Sustainability Potential

Q11. What would make this framework something you **actually use**, rather than another policy document?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Moderator asks: What would make this framework something you actually use? What one or two barriers could limit long-term use??

Moderator probes: workload, training, leadership support

Moderator notes: Focus on actionable barriers.

Closing Question (Teachers)

Q13. If you could change **one thing** in the framework to make it more useful for teachers, what would it be?

Workshop 2 Policymakers & Experts

Opening & Framing

Moderator says: Thank you for participating. Today we are validating this framework as a reference tool for systems, not as a mandate or curriculum. We are interested in its coherence, policy relevance, and sustainability.

Ground rules (brief):

- System-level perspective
- Concrete policy implications
- Constructive critique welcomed

Discussion by Core Decision Dimensions

- Timing guideline: ~60 minutes per dimension

- Use probes selectively if discussion stalls.

Closing Question

Ask everyone: What is the **single most important improvement** needed for this framework to function as a credible policy instrument?

Moderator note: Capture each response verbatim if possible.

Wrap-up

- Thank participants.
- Explain how feedback feeds into revisions and cross-national synthesis.
- Remind them to complete the post-workshop consensus survey.

1. Structural Clarity & Coherence

Q1. From a system or policy perspective, does the framework present a **clear and coherent model** of data literacy for compulsory education?

Q2. Is the internal logic between domains, progression bands, and proficiency levels appropriate for use as a **reference framework**?

Moderator asks: Does the framework present a clear and coherent competence model? Is the internal logic suitable for reference use?

Moderator probes: hierarchy, scalability, policy readability

Moderator notes: Focus on reference-framework quality, not implementation yet.

2. Domain Completeness & Balance

Q3. Do the seven domains together provide a **complete and balanced** picture of data literacy at system level?

Q4. Are any domains insufficiently developed, overly complex, or misaligned with current policy priorities?

Moderator asks: Do the seven domains provide a complete picture at system level? Are any domains misaligned with current priorities?

Moderator probes: AI/automation, ethics & governance

Moderator notes: Ask whether anything is missing for policy.

3. Progression Logic (Bands + Proficiency)

Q5. How well does the progression logic align with curriculum design, learning outcomes, and assessment practices in your context?

Q6. Is the progression flexible enough to accommodate **national and institutional variation**?

Moderator asks: How well does the progression align with curricula and assessment? Is it flexible enough for national variation?

Moderator probes: competence-based curricula, age benchmarks

Moderator notes: Look for concerns about standardisation vs flexibility.

4. System Applicability

Q7. In which concrete ways could this framework be used at system level (e.g. curriculum guidance, teacher PD, quality assurance)?

Q8. What implementation pathways seem realistic, and which seem problematic?

Moderator asks: How could this framework realistically be used (curriculum, PD, QA)? Which pathways seem realistic or problematic?

Moderator probes: governance, institutional capacity

Moderator notes: Capture entry points into the system.

5. Ethical Robustness & Equity

Q9. Does the framework sufficiently address **ethical, legal, and societal issues** related to data use in education?

Q10. Are there equity or rights-based considerations that should be more explicitly addressed at policy level?

Moderator asks: Are ethical and legal aspects sufficiently explicit? Are equity and rights-based issues adequately addressed?

Moderator probes: GDPR, algorithmic decision-making, student agency

Moderator notes: Ethics often scores high - probe operational clarity.

6. Adoption & Sustainability Potential

Q11. What conditions would be necessary for this framework to achieve **long-term adoption** rather than short-term endorsement?

Q12. What risks might undermine sustainability at national or system level?

Moderator asks: What conditions are necessary for long-term adoption? What risks could undermine sustainability?

Moderator probes: policy fragmentation, reform fatigue

Moderator notes: Separate political from operational risks.

Closing Question (Policymakers / Experts)

Q13. What is the **single most important improvement** needed for this framework to function as a credible policy instrument?

National Reports

Following the completion of the workshops, each partner research team was responsible for preparing a national report that summarizes the key findings from the validation process. These reports served as the basis for consolidating insights across countries and informing them of the final refinement of the Data Literacy Skills Framework. Each national report:

- Highlight stakeholder perspectives and feedback trends.
- Identify areas of the framework requiring revision, clarification, or expansion.
- Outline specific recommendations for enhancing the framework.
- Assess the framework's perceived feasibility, applicability, and adaptability within the national context.

These reports contribute to the consolidated cross-country analysis, providing a validated foundation for subsequent activities in WP3 and WP4. Each report is presented to the following sections, based on a structured template.

National Report Greece

Authors: Charalampos Mouzakis, Lefkothea Biniari, Apostolos Kostas

Executive Summary

This National Report presents the outcomes of the Greek validation workshops conducted within the DATA-READY project to assess the coherence, relevance, and implementation potential of the proposed Data Literacy Framework for compulsory education. Two workshops were organized: one with policymakers, experts, and institutional stakeholders (blended, hosted by AQAPSE, in Athens) and one with in-service teachers from primary and lower secondary education (face-to-face, hosted by UAegean, Rhodes). Together, these workshops provided complementary system-level and classroom-level evidence to inform targeted refinement of the Framework.

Across both groups, there was strong consensus that the Data Literacy Framework constitutes a **conceptually robust, coherent, and future-oriented reference model**, aligned with established European competence frameworks and current policy priorities. Its domain-based architecture was widely recognized as logically organized, comprehensive, and suitable for cross-curricular application, positioning data literacy as a transversal educational and civic competence. Policymakers emphasized its methodological legitimacy and value as a system-level reference tool for curriculum alignment, professional development, and quality assurance.

At the same time, validation findings clearly distinguished between **structural coherence at reference level and usability at implementation level**. Teachers identified conceptual overlaps between closely related domains, particularly at early progression stages, which reduce the clarity of the Framework at classroom level. They proposed consolidation or hierarchical organization of adjacent domains and strongly recommended repositioning Awareness, Ethics & Agency as a transversal layer influencing all data-related activity rather than as a standalone domain. Both teachers and policymakers rejected a strictly linear interpretation of the Framework, favoring a spiral or networked logic aligned with inquiry-based and project-based pedagogies.

The **progression logic (bands and proficiency levels)** emerged as the most critical area for refinement. Teachers argued that age-based bands may not reflect classroom realities, where learners show uneven, domain-specific development shaped by maturity, context, and opportunity. They advocated redefining bands as flexible pedagogical zones and restructuring proficiency levels to be domain-specific, finer-grained, and based on observable autonomy rather than idealized technical complexity. Policymakers broadly endorsed the progression architecture but stressed the need for flexibility, continuity across the primary–secondary transition, and explicit bridging mechanisms.

Regarding **classroom applicability**, both groups agreed that the Framework should not be implemented holistically or prescriptively. Instead, it is most viable when used selectively, with low-threshold entry points such as questioning, problem framing, data acquisition from immediate contexts, and basic representation. Scenario-based resources, phased piloting, and alignment with existing curricula were identified as essential. Through discussions, teacher capacity, rather than student readiness, was consistently identified as the primary limiting factor, highlighting the central role of sustained, practice-oriented professional development.

The **ethical dimension** was unanimously recognized as a defining strength of the Framework, closely linked to critical thinking, responsible data use, and active citizenship. However, emerging challenges related to generative AI, authorship, transparency, bias, and equity require more explicit integration. Overall, the Greek validation workshops confirm the Framework’s strong

conceptual foundation while clearly signaling the need for **targeted design-level refinements** to support realistic, equitable, and sustainable adoption across compulsory education.

Organization of the workshops

Participants for the validation workshop for **policy experts and stakeholders** were recruited through professional networks, curriculum development institutions (Institute of Educational Policy – IEP), educational advisory bodies, higher education institutions, and policy structures. Targeted invitations were extended to individuals with expertise in curriculum design, educational technology, Computer Science education, primary education pedagogy, and educational policy development.

The recruitment process yielded 11 senior stakeholders representing a range of educational, academic, and public administration institutions, including the Greek Ministry of Education, higher education institutions and central public authorities. Participants occupied roles associated with teaching and research in higher education, public administration, and educational policy, indicating a high level of relevance to systemic and policy-oriented decision-making.

Prior to the workshop, all participants received a comprehensive preparatory package including (a) a concise summary of the Data Literacy Framework, its rationale, and theoretical grounding, (b) the main findings from the D2.1 DATA READY report, with emphasis on Greek national results, (c) the discussion protocol outlining the six core validation dimensions and (d) a pre-workshop validation survey designed to capture baseline perceptions and contextual information. This preparatory process ensured that participants engaged with the framework material prior to deliberations, facilitating more focused, informed, and productive discussions during the workshop itself. The use of preparatory questionnaires to ensure informed participation demonstrates methodological rigor that strengthens confidence in the findings and provides a model for subsequent consultation processes.

Teachers from compulsory education schools within the North Aegean Educational Region were invited to participate in the workshop. Participants were purposefully selected to ensure diversity and representativeness, based on the following criteria: (a) coverage of both primary and lower secondary education; (b) representation of different subject areas (e.g., ICT, Physical Sciences, Social Sciences); (c) inclusion of teachers with various academic qualifications, from diplomas to doctoral degrees; (d) variation in years and levels of professional experience; and (e) participation from both public and private school sectors.

Following these criteria, the final group consisted of 11 teachers with diverse educational backgrounds and professional profiles, supporting a pluralistic and multi-perspective discussion. The workshop was held in a face-to-face format, as all participants were based in Rhodes, Greece, where the Department of Primary Education is located. Invitations were sent via email and included links to the project website, the full draft of the Data Literacy Framework, and an accompanying executive summary. This method ensured that participants were well-informed about the DATA-READY project, its objectives and initial results, as well as the framework being validated, prior to the workshop.

Additionally, an executive summary was prepared and shared, emphasizing key aspects of the DATA-READY project, the main features of the draft Data Literacy Framework, and the role of stakeholders in the overall project implementation and validation process.

Implementation of the Workshops

The validation workshop for **policy experts and stakeholders** was conducted on 15th January 2026 as a one-day event comprising six hours of structured discussion plus two hours of

scheduled breaks. The workshop was designed to systematically examine the proposed Data Literacy Framework across six core validation dimensions, eliciting expert perspectives on structural coherence, content completeness, progression logic, applicability, ethical considerations, and adoption potential. The workshop was held at the Authority for Quality Assurance in Primary and Secondary Education in Maroussi, Attica.

Workshop participants included 11 senior stakeholders representing:

- Curriculum development specialists from the Institute of Educational Policy (IEP).
- Educational advisors and quality assurance experts.
- Higher education faculty members specialized in educational technology and Computer Science education.
- Primary education pedagogy experts.
- Educational policy analysts and researchers.
- Representatives from central public authorities with educational portfolios.

Most participants held doctoral or post-doctoral qualifications, with academic specializations in education, educational technology, educational policy, and digital pedagogy. This composition ensured that deliberations benefited from multiple institutional perspectives, encompassing both theoretical considerations and practical implementation realities. Participants' reported levels of influence spanning institutional, local, and national contexts enabled examination of the framework from strategic, operational, and policy perspectives simultaneously. The workshop followed a structured agenda comprising two main components: a presentation segment and a moderated discussion segment organized around the six core validation dimensions.

The validation workshop for **teachers** was held as a face-to-face event on 29th January 2026. It took place at the Future Lab facilities of the Department of Primary Education, School of Humanities, University of the Aegean, in Rhodes, Greece, and was jointly organized by the University of the Aegean and Rodos College project partners.

The schedule of both workshops included opening session (welcome, icebreaking), presentation, discussion, and closing part:

- **Opening**
 - Welcome & objectives
 - Ice-breaking activity
- **Presentation**
 - WP2 preliminary research findings
 - National results from D2.1 DATA-READY report
 - Draft Data Literacy Framework (DLF)
- **Discussion**
 - Validation-oriented discussion
- **Closing**
 - Key takeaways
 - Next steps & feedback process

Presentation Part

For the **stakeholders**, the workshop commenced with a comprehensive presentation of the preliminary research findings from Work Package 2, including the main findings from the D2.1 DATA READY report. The presentation emphasized prior research findings from the D2.1 DATA READY report, including analysis of curricula and policy documents from five partner countries revealing fragmented data literacy integration across European contexts. Emphasis was placed

on the Greek national results, which provided the empirical foundation for framework validation within the national context. Planned project deliverables were outlined, including the development of 120 learning scenarios covering different domains and progression levels, and coordination with two additional European projects in the data literacy field to ensure alignment and comprehensive coverage. Participants were invited to reflect on how these findings resonated with their professional experience and institutional knowledge, thereby grounding subsequent deliberations in contextually relevant evidence. The proposed Data Literacy Framework was subsequently presented, addressing its rational and theoretical grounding, regarding domains, progression bands and proficiency levels. Participants were provided with visual representations of the framework structure and invited to pose clarifying questions prior to the discussion segment. This presentation phase ensured common understanding of the framework's architecture and objectives, enabling more focused and substantive engagement during deliberations.

For the **teachers'** validation workshop, during the presentation, the facilitators provided a brief overview of the DATA-READY project and highlighted key findings from the initial Data Literacy study, with particular focus on results from the Greek national context. Afterward, the draft Data Literacy Framework was introduced, including its rationale, theoretical basis, and overall structure, along with the core thematic areas to be addressed in the workshop. Participants were asked to confirm whether they had reviewed the framework beforehand. The discussion protocol was then clearly explained, covering its objectives, process, and expected contributions, and was formally agreed upon by all participants before the validation discussion commenced.

Discussion Part - Teachers

This section reports the findings from the teachers' validation workshop, focusing on the framework's clarity, coherence, and potential for systemic adoption in compulsory education. Teachers' contributions are regarded not only as reflections of classroom practice but also as practice-informed evidence relevant to curriculum design, teacher professional development, and policy implementation. The discussion considers whether the framework's domains, progression bands, and proficiency levels provide a coherent and adaptable structure that can be incorporated into existing national curricula, cross-curricular initiatives, and assessment methods without adding unnecessary complexity or workload.

Using a qualitative thematic analysis of focus group data, this section identifies patterns of agreement and divergence in teachers' perspectives, highlighting both strengths of the proposed structure and areas requiring refinement to enhance usability, scalability, and alignment with educational systems. Attention is paid to teachers' views on domain differentiation, cross-cutting principles (such as ethics, critical data awareness, and reflection), and the framework's capacity to support interdisciplinary and project-based learning at scale. The findings reported here therefore offer evidence-based insights to inform policy decisions regarding the framework's refinement, national adaptation, and long-term sustainability within compulsory education systems.

Dimension 1: Structural Clarity & Coherence

Q1. When you look at the framework, what feels clear and usable for you as a teacher, and what feels complex or difficult to navigate?

Q2. Do the domains, progression bands, and proficiency levels work together in a way that makes sense for classroom use, or are there points where the structure feels confusing?

Structural clarity and readability

There is strong basic acceptance of the Framework's architecture, which enhances its structural validity as a reference tool for teachers. Most participants recognize that the Framework is well-structured, clear, and logically organized, with distinct dimensions that “make sense” for educational practice. The presence of progression zones and levels is viewed as a positive feature, particularly for planning teaching.

Overlaps between dimensions

One of the most frequent issues relates to the overlap of concepts across specific domains, mainly representation, visualization and modelling. Participants find it difficult to perceive their boundaries and functional differences. The criticism is not about the existence of these dimensions but about the clarity of their conceptual boundaries. There is a need either for conceptual clarification or for structural merging / hierarchy.

Horizontal role of Awareness, Ethics & Agency

The Awareness/Ethics domain is recognized as crucial, but many participants view it more as a horizontal aspect than as an independent domain. A structural tension arises because, although the dimension is seen as fundamental, its inclusion as “another domain” causes confusion. This highlights the need for an explicit statement of its horizontal character within the model.

Non-linearity and dependencies between domains

Some participants question the fixed or linear nature of the Framework, pointing out that the order of domains varies across different scientific disciplines and pedagogical contexts. The Framework is viewed more as a cycle or a network of relationships rather than a simple, direct pathway. This perspective is closely connected to interdisciplinary and project-based scenarios.

Project-Based Learning and Feedback

A deficit is identified in the explicit representation of feedback and reflection, especially within the context of project-based learning, primarily in secondary education. The observation highlights that, despite its structural completeness, the Framework needs a clearer connection to pedagogical learning cycles, where reflection is a fundamental element.

Generalizability and applicability to all grades

Questions arise about the coverage of all grades (e.g., kindergarten) and the practicality of implementing it across all levels, considering time and organizational constraints. The structure is seen as pedagogically strong, but concerns about institutional and practical adaptation to the national context are raised.

Critical dimension and non-neutrality of data

A participant notes that, despite the reference to ethics, the idea that data is not neutral is not sufficiently clear, nor does the logic of critical thinking clearly permeate the framework. This observation directly relates to the discussion on the horizontal role of the critical and ethical dimension and emphasizes the need for a more explicit theoretical framework.

Dimension 2: Domain Completeness & Balance

Q3. Taken together, do the seven domains capture what data literacy should realistically mean for students in compulsory education?

Q4. Are any domains overlapping, missing, or too dominant compared to others from a teaching perspective?

Perceived conceptual completeness

Most participants recognize that the Framework comprehensively covers the field of data literacy and provides a robust mapping of the necessary skills for the modern citizen and student. The completeness of the domain is viewed positively at a theoretical level. The domains are regarded as an appropriate reference framework, even if not all are directly applicable.

Developmental asymmetry of domains

There is strong and repeated criticism that certain domains, mainly Modelling & Automation, surpass the cognitive and pedagogical capabilities of primary education. The value of these domains is not in doubt, but their appropriateness for age is questioned. Emphasis is placed on the need for developmental hierarchy rather than horizontal parity.

Imbalance between theoretical approach and school reality

Teachers highlight a significant gap between the theoretical scope of the domains and their real-world application in today's schools. The Framework is seen as aspirational, with limited system readiness, which impacts how the domains are balanced in practice.

Limited student readiness in basic data skills

Many participants highlight basic weaknesses in students (even in high school) regarding understanding, analyzing, and communicating data. The discussion moves from “whether domains are missing” to “whether they can be supported.” Balance relates to the level of depth, not the number of domains.

Lack of separation of core vs advanced domains

Participants note that all domains are presented as equally important, without clear prioritization by age or subject. A need for domain balance through prioritization, not abstraction, is emphasized.

Critical role of teacher training

The completeness of the domains is directly linked to the assumption that teachers themselves do not sufficiently possess many of the described competencies. The balance among the domains cannot be examined independently of teachers' readiness. The Framework presupposes a systemic investment in training.

Data literacy as a horizontal civic competence

Some participants reframe data literacy not as a school subject but as a broad life and civic skill. This observation supports the idea of domain completeness but also highlights the need for realistic, gradual implementation.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. Does the progression from Primary 1 to Lower Secondary reflect how your students actually develop data-related skills over time?

Q6. Do the proficiency levels (Starting–Intermediate–Advanced) help you understand expectations, or do they risk being confusing or unrealistic?

Transition gap from Primary to Secondary Education

The participants recognize a systematic issue with the transition between Primary and Secondary Education, which they believe directly, impacts the functionality of the progression bands. The sudden institutional and pedagogical change does not keep pace with the ongoing developmental path of students, creating gaps in the logic of the bands.

Criticism of the linearity of the progression levels

Many educators challenge the idea of a straight line in progress, recognizing that learning and the development of data literacy skills are non-linear. Progress often feels cyclical and upward spiraling, with overlaps across different ages and levels, which the current model does not sufficiently reflect.

Need for finer gradation

Several participants suggest a more detailed segmentation of the progression bands, especially in Primary and Secondary Education. Broad groupings (e.g., P1, P2, LS) are seen as pedagogically coarse and fail to capture small but important differences.

Age-maturity-proficiency level mismatch

Educators emphasize that proficiency levels do not adequately account for individual maturity, emotional development, and learning difficulties. The same age does not equate to the same readiness; therefore, proficiency levels require flexibility and differentiation.

Emotional and psychosocial factors

Emphasis is placed on distinguishing the emotional context between primary and secondary school, with increased pressure on secondary education. Progress in skills is not only cognitive but also emotionally mediated, which is absent from the current structure.

Advanced level feasibility

There is considerable doubt about whether the Advanced level is realistically attainable within Secondary Education. The Advanced level serves more as an aspirational benchmark than as a defined learning outcome.

Need for the introduction of a preschool level

Many participants highlighted the lack of kindergarten in the progression logic. The omission of the preschool level causes a gap at the start of the developmental chain.

Need for alternative readiness categories

It is suggested to substitute or add to proficiency levels with readiness or usage levels. Proficiency levels require more practical, less standardized terminology.

Inequalities and differentiations

Teachers emphasize differences based on school type, region, socio-economic status, and cultural context. The progression logic cannot be impartial to context; specific provisions for adaptations are necessary.

Need for objectification through scenarios

Participants request specific scenarios that “translate” the levels into practice. Without examples of application, progression and proficiency levels remain abstract.

Dimension 4: Classroom Applicability

Q7. If you were asked to start using this framework next school year, where would you realistically begin?

Q8. What aspects of the framework feel most practically useful, and which feels hardest to apply in everyday teaching?

Starting with questioning and problem understanding

Many participants agreed that the most realistic and pedagogically sound starting point for implementation is questioning, combined with the analysis of a problematic situation and the

formulation of questions by students. This approach was regarded as feasible because it does not require advanced technological infrastructure, can be adapted across all educational levels, and aligns well with established pedagogical practices such as STEM education and Project-Based Learning (PBL). In this sense, questioning acts as a low-threshold entry point into the framework, enabling gradual engagement without disturbing existing teaching routines.

Gradual rather than holistic implementation

Participants clearly rejected the idea of implementing the entire framework from the outset. Instead, they supported a phased and pilot-based approach, starting with selected domains or levels and tailoring them to specific classroom and subject contexts. Emphasis was placed on the need for time to allow students to become familiar with data-related practices. Implementation was therefore seen as a process developing over several months, rather than as a single, standalone project.

Need for initial linearity for beginners

Although the framework is fundamentally non-linear, participants suggested that, for novice learners (and in some cases novice teachers), a temporary linear sequence might be pedagogically helpful. Examples given included starting with Questioning, then Data Acquisition and Basic Analysis, only later introducing additional domains as experience grows. In this view, linearity is seen as a didactic scaffold rather than a strict structural constraint, which can be gradually loosened as learners gain confidence and competence.

Practically useful elements of the framework

Participants identified Questioning and Problem Framing, Data Acquisition from students' immediate environment, and Data Representations (graphical and visual) as the most easily applicable domains. These elements were regarded as straightforward to align with the existing curriculum, capable of being integrated without fundamentally changing subject teaching, and functioning in a complementary rather than competing way to established instructional practices.

Differentiated implementation as practical value

The framework was seen as highly valuable because it supports varied implementation. Participants mentioned that it allows for multiple student roles, encourages collaborative work, and offers various entry points into learning activities. This flexibility was considered especially important for helping students with different abilities and prior knowledge, thereby reducing the risk of exclusion and fostering more inclusive classroom practices.

Most challenging aspects of implementation

The most challenging aspects identified were full modelling, process automation, and the integration of all domains within a single project. These challenges were mainly due to limited instructional time, the constraint of few teaching hours per week in courses like ICT of Physical Sciences, and the extensive preparation needed to effectively implement these components into everyday teaching.

Structural constraints of school reality

Participants identified several structural barriers within the school system, including limited collaboration among teachers, challenges in cross-curricular implementation, especially at the lower secondary level, and inequalities in school infrastructure. The framework was considered more easily applicable in primary education, whereas greater difficulties occur in contexts where teaching is strictly subject-specific and classified.

Risk of technocratic implementation

Participants expressed concern about the risk of a technocratic approach, where excessive focus on technical aspects could overshadow the pedagogical significance of data literacy. They emphasized that successful implementation depends not on the completeness of framework coverage, but on the meaning-making and educational purpose of each step within the learning process.

Dimension 5: Ethical Robustness & Equity

Q9. How confident would you feel using this framework to address issues such as privacy, bias, fairness, and responsible data use with your students?

Q10. Does the framework support inclusive practice for diverse learners, or are there areas where equity needs to be more explicit?

Ethics as a cross-cutting dimension rather than a procedural step

Participants consistently view ethical considerations, such as privacy, bias, fairness, and responsibility, not as separate stages in the framework but as guiding principles that should influence all parts of data work. Ethical reasoning is expected to develop through ongoing reflection and classroom discussion across questioning, data collection, analysis, representation, and action, rather than through a checklist or linear approach. There is notable skepticism towards treating ethics as a “final step” or standalone domain. Participants’ confidence in the framework’s ethical capabilities is therefore conditional and largely depends on whether educators intentionally highlight ethical issues throughout learning activities.

Privacy and data protection

Concerns over privacy and student data protection have become an area of relatively low confidence. Participants highlighted that many students lack the maturity, digital awareness, and procedural knowledge necessary to manage data responsibly. At the same time, the use of digital platforms and data-sharing tools is viewed as inherently risky, with unclear boundaries between pedagogical data use and the exposure of personal information. Several participants emphasized the need for clearer institutional, regulatory, or policy-level guidance; particularly regarding what types of data can be collected, stored, or shared. Without such safeguards, confidence in the framework’s capacity to effectively address privacy remains limited.

Bias

Bias was broadly recognized as a key learning aim, particularly concerning data interpretation and emerging AI-related practices. Participants showed confidence in tackling bias on a conceptual and discussion level. However, uncertainty remains around methodology, especially in relation to AI-generated data. Some participants saw such data as pedagogically beneficial for demonstrating bias, while others expressed concerns about potential risks to scientific validity and epistemic trust. Consequently, confidence in teaching bias varies, with clearer educational goals than definitive methodological boundaries.

Generative AI highlights emerging ethical gaps in the framework

Participants observed that the project was developed before the widespread adoption of generative AI in classrooms. As AI tools increasingly automate key aspects of the framework, such as data creation, analysis, and visualization, new ethical concerns emerge related to authorship, learner agency, transparency, and the accuracy of data-driven results. Consequently, participants expressed cautious confidence, acknowledging the framework’s relevance while also recognizing that it has yet to fully address the ethical issues introduced by AI-enhanced learning environments.

Inclusion as an implicit rather than explicit design principle

The framework was generally seen as capable of supporting inclusive practice. However, participants noted that inclusivity is not always clearly expressed within its structure or descriptors. Instead, inclusion seems to depend significantly on teachers' interpretations and pedagogical choices. Consequently, inclusion is regarded as an emerging outcome rather than an explicitly stated design principle. Participants highlighted an equity gap, especially concerning the explicit consideration of learners with disabilities, linguistic and cultural diversity, and differentiated learning paths.

Differentiated participation as a mechanism for practical equity

Participants described specific pedagogical strategies to effectively realize equity within the framework. These include collaborative group work with differentiated roles (e.g., data collection, visualization, interpretation), multiple modes of representation (visual, verbal, tactile), and flexible entry points into tasks. Such practices were viewed as reducing exclusion and enabling meaningful participation from students with diverse strengths and needs. When applied flexibly, the framework was seen as supporting functional and practice-based equity.

Systemic constraints as barriers to equitable implementation

Equity-related concerns were extended beyond classroom practice to include structural and systemic issues. Participants emphasized uneven school infrastructure, limited opportunities for teacher collaboration, and unequal access to professional development and resources as critical challenges. Without coordinated institutional support, participants warned that the framework risks being implemented inconsistently, potentially reinforcing existing educational inequalities instead of reducing them.

Dimension 6: Adoption & Sustainability Potential

Q11. What would make this framework something you actually use, rather than another policy document?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Practical vs. abstract guidance

Participants consistently distinguish between frameworks that are conceptually read and those that are practically used. What was identified as a key factor for genuine adoption was the availability of concrete classroom examples, short and adaptable learning scenarios, and clearly articulated entry points showing how the framework can be integrated into existing lessons. Participants explicitly stated that they do not intend to “apply the framework in its entirety,” but rather to select and reuse elements that are meaningful for their subject area and educational level. In this sense, adoption is closely linked to the framework functioning as a practical toolkit, rather than as a normative or declarative document.

Alignment with existing curricula and pedagogical routines

Sustained implementation was viewed as practical only if the framework complements rather than replaces existing teaching methods. Participants stressed the importance of aligning with current curricula, assessment arrangements, and subject structures, without requiring significant timetable reorganization or disciplinary restructuring. The framework was seen favorably when it was regarded as enriching established lessons, for instance, by adding data literacy perspectives, while allowing educators to keep familiar pedagogical approaches. Perceived sustainability was higher when the framework was viewed as an addition rather than a disruption.

Teacher agency as a condition for meaningful adoption

Participants emphasized that teacher autonomy, professional judgement, and contextual adaptation are essential for meaningful and lasting engagement with the framework. Imposed implementation was linked to risks of superficial compliance rather than authentic pedagogical integration. Through discussions, intrinsic motivation, based on perceived value and relevance, was repeatedly seen as more effective than obligation. Therefore, adoption was associated with professional ownership rather than enforcement.

Professional development as a key enabling factor

Teacher professional development was consistently recognized as a vital enabler for both understanding the framework's purpose and applying it confidently over time. Participants described effective professional development as practice-based, ongoing rather than one-off, and explicitly focused on how the framework can be utilized in classroom settings, rather than merely explaining what the framework is. Without such support, participants warned that the framework risks remaining theoretically sound but being practically underused.

Time limitations and workload pressures

Participants consistently highlighted limited instructional time, high curriculum density, and few opportunities for pedagogical experimentation as key constraints. Framework-informed approaches were seen as relatively time-consuming, especially in settings where subjects have only one hour of instruction weekly. Without realistic allowances for time, planning, and iteration, sustained adoption was regarded as fragile and hard to sustain.

Risk of mechanistic or symbolic implementation

A recurring concern was that the framework could be reduced to a mechanistic checklist, applied superficially to meet reporting or policy compliance requirements. Such "box-ticking" approaches were seen as undermining the framework's pedagogical value and likely to cause disengagement or eventual abandonment. Participants noted that using the framework only in name, without genuine or meaningful application, was considered worse than not using it at all because it erodes trust and discourages authentic engagement and motivation.

Variability in school contexts and systemic inequalities

Participants noted that schools vary greatly in their infrastructure, access to technology, opportunities for collaboration, and leadership support. These variations are likely to cause uneven adoption of the framework and could reinforce existing inequalities between schools. In environments where teachers mainly work in isolation or where institutional support is limited, sustained and meaningful implementation was considered particularly challenging.

Ambiguity around goals and assessment criteria

Some participants were uncertain about what constitutes successful use of the framework and how to assess student progress across the different domains. Without clearer indicators or practical assessment tools, teachers may struggle to evaluate impact, explain results, or justify the time and effort invested. This uncertainty was viewed as a barrier to the ongoing and systematic application of the framework.

Closing question

Q13. If you could change one thing in the framework to make it more useful for teachers, what would it be?

Suggestions about Domains

Teachers consistently emphasized that, in practice, Data Acquisition (DA) and Problem Framing (PF) are inseparable, particularly in early classroom activities. Treating them as distinct areas can make initial implementation seem artificial and overly structured.

They proposed merging the two domains into one, such as Problem exploration and Data generation (PD), which would include asking questions, defining the problem, and identifying or collecting data. These activities mainly exist in lower bands and early levels, only splitting into separate domains at higher bands.

Following the same logic, teachers suggested merging Analysis & Interpretation (AI) with Communication & Action (CA), and Modelling & Automation (MA) with Representation & Visualization (RV).

Regarding Awareness, Ethics & Agency (AE), they recommended repositioning it as a transversal layer rather than a standalone domain. For example, they proposed removing it from the linear progression chart and representing it visually as an outer ring or overlay that influences all other domains. Following this approach, they suggested linking ethics with decision-making and action instead of analysis, since ethics are more naturally connected to communication, action, and consequences rather than technical aspects. Additionally, they recommended providing guiding ethical questions rather than skills or outcomes. Furthermore, they suggested expanding awareness to include critical tool awareness, especially in the era of GenAI tools.

Suggestions about Progression Bands

Teachers consistently expressed that progression bands would be more useful if they were separated from strict age assumptions and redefined as flexible pedagogical zones. They pointed out that age-based banding does not reflect the diversity of real classrooms, where students of the same age show varying levels of progress across different areas. Teachers therefore suggested narrower, more precise bands, domain-specific alignment, and a shift from using chronological age to prioritizing pedagogical experience as the main organizing principle. Without these adjustments, progression bands risk remaining merely descriptive categories rather than practical tools for classroom planning.

In this sense, teachers did not request the removal of progression bands, but they asked to redefine what the bands represent. Specifically, they want bands to cease functioning as age labels, instead acting as flexible orientation zones, becoming narrower and more precise, allowing uneven, domain-specific alignment and reflecting experience and exposure rather than chronology.

So, finally, the proposed six (6) progression bands:

- Band 1 (Grade 1-2)
- Band 2 (Grade 3-4)
- Band 3 (Grade 5-6)
- Band 4 (Grade 7)
- Band 5 (Grade 8)
- Band 6 (Grade 9)

Suggestions about Proficiency Levels

Teachers' responses indicate that the current proficiency levels might require significant restructuring to be genuinely useful in classroom practice. They argued that the levels are too broad to reflect meaningful learning progress, as advances often occur within levels rather than through clear transitions between them. For this reason, they proposed dividing each level into smaller, more precise sub-levels so that progress becomes visible and achievable within realistic teaching timeframes.

Teachers also emphasized that proficiency levels must be explicitly specific to each domain, as students generally perform at different levels across various fields, and expectations of uniform progress do not match classroom realities. Additionally, they argued that levels should be defined based on observable autonomy, independence, and decision-making rather than idealized technical complexity. This approach would ensure that early levels remain accessible in low-resource settings and that partial progress is clearly recognized. Without these adjustments, teachers warned proficiency levels will continue to serve as abstract reference points rather than as practical tools for planning, monitoring, and implementing the framework effectively in classrooms.

Discussion Part - Policymakers/Experts

Dimension 1: Structural Clarity & Coherence

Q1. From a system or policy perspective, does the framework present a clear and coherent model of data literacy for compulsory education?

Q2. Is the internal logic between domains, progression bands, and proficiency levels appropriate for use as a reference framework?

Strong overall structural coherence

Stakeholders broadly agreed that the Framework presents a clear, coherent, and well-organized model of data literacy suitable for compulsory education at system level. Domain-based architecture was seen as logical, navigable, and immediately comprehensible, with the internal organization supporting a holistic view of data literacy across education. This coherence should be retained as a core strength, with no need for structural redesign, as it provides a stable foundation for policy discussion, curriculum alignment, and system-level adoption.

Alignment with established frameworks

Participants repeatedly emphasized that the Framework's structure mirrors established European competency models (e.g. DigComp, GreenComp), which enhances its credibility, transferability, and acceptability for policymakers and curriculum authorities. This alignment was viewed as conferring methodological legitimacy and easing integration into existing policy ecosystems. Any revisions should therefore preserve continuity with European framework conventions, avoiding changes that could weaken perceived comparability or policy trust.

Cross-Curricular structural applicability

Stakeholders highlighted the Framework's capacity to operate across all curriculum areas, stressing that data literacy is inherently transversal and not confined to computer science or STEM. The seven domains were seen as collectively relevant to the full curriculum, enabling engagement by non-specialist educators and supporting interdisciplinary integration. This reinforces the need to maintain and further clarify the Framework's cross-curricular orientation, particularly at policy and system-design level.

Ethical and critical dimensions

The explicit inclusion of ethical, critical, and pedagogical dimensions was recognized as a defining structural strength, aligning the Framework with contemporary concerns around data governance, responsibility, and citizenship. Stakeholders viewed these elements as integral rather than supplementary, enhancing the Framework's relevance beyond technical skill development. This confirms that ethical and critical aspects should remain structurally central and visibly embedded across domains, rather than repositioned or diluted.

Insufficient conceptual and terminological clarification

Despite overall structural clarity, stakeholders identified a need for stronger conceptual grounding, particularly regarding core distinctions (e.g. data vs. information) and the use of technical terminology. Without clearer conceptual framing, there is a risk that less expert audiences may misinterpret or oversimplify the Framework during implementation. This points to the need for expanded conceptual documentation (glossaries, theoretical notes, framing sections) without altering the Framework’s structural design.

Framework as reference, not prescription

A key shared understanding emerged that the Framework should function as a foundational reference document, not a prescriptive curriculum or implementation blueprint. Stakeholders endorsed this positioning to reconcile theoretical completeness with contextual flexibility, allowing systems and institutions to adapt selectively according to capacity and priorities. This identity should be made explicit in the Framework’s positioning and language, reinforcing flexibility at the implementation level rather than through structural simplification.

Dimension 2: Domain Completeness & Balance

Q3. Do the seven domains together provide a complete and balanced picture of data literacy at system level?

Q4. Are any domains insufficiently developed, overly complex, or misaligned with current policy priorities?

Overall completeness of the domain set

Stakeholders broadly agreed that the seven domains together provide a complete representation of data literacy for compulsory education, capturing technical, ethical, pedagogical, and civic dimensions in a way that is appropriate for system-level frameworks. The model was seen as sufficiently comprehensive to reflect contemporary understandings of data literacy and capable of engaging educators beyond computer science, reinforcing its relevance for whole-system adoption. This completeness should be preserved as a defining characteristic, as it positions the framework as future-oriented and policy-relevant.

Alignment with existing curricula

Participants consistently emphasized that all domains are applicable across the curriculum, reinforcing the view that data literacy is inherently transversal and not confined to specific subjects. The assertion that “no cognitive domain exists without data applicability” underpinned strong endorsement of the framework’s cross-curricular ambition. This confirms that the domains should continue to be framed as system-wide enablers, with further clarification on how different subjects may selectively engage with different domains.

Inter-Domain Overlap

Despite overall completeness, stakeholders identified significant conceptual and functional overlaps between several domains, particularly between data acquisition/representation, analysis/modelling, and communication/action. These overlaps were perceived as potentially reducing clarity and usability, especially for non-expert users. This points to a need for either clearer boundary articulation or selective consolidation to improve navigability without undermining conceptual integrity.

Domain consolidation

A recurring recommendation was to reduce the total number of domains (e.g. from seven to five) through strategic mergers, motivated by concerns about feasibility, cognitive load, and alignment with existing curricula that typically address fewer data-related areas. Stakeholders linked this to the rapidly evolving digital landscape and the need for structurally aligned frameworks at policy

level. This suggests that domain consolidation is a viable design option, provided it does not compromise conceptual coverage.

Modelling & Automation as unevenly implementable

The modelling and automation domain was singled out as potentially problematic for universal implementation due to infrastructural, curricular, and capacity constraints across schools and countries. Stakeholders noted that such competencies are often unevenly distributed or only partially present in current curricula. This raises the need to explicitly position certain domains as context-dependent or advanced, rather than universally expected at system level.

Emerging gaps: Big Data and AI

Participants noted the absence of explicit reference to big data and the limited visibility of artificial intelligence as a horizontal concern, despite their growing relevance in education and society. While stakeholders accepted the current focus on foundational data literacy, they argued that explicit acknowledgment of these areas would future proof the framework. This indicates a need for clearer signalling of emerging fields, potentially through cross-cutting references rather than new standalone domains.

Completeness vs. flexible implementation

Alongside calls for consolidation, a counter-position was articulated: the framework should retain its full domain set to ensure conceptual completeness, while allowing selective or phased implementation depending on national, institutional, or infrastructural conditions. This view reframes the tension between completeness and usability as an implementation issue rather than a design flaw, suggesting that flexibility mechanisms may be preferable to structural reduction.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. How well does the progression logic align with curriculum design, learning outcomes, and assessment practices in your context?

Q6. Is the progression flexible enough to accommodate national and institutional variation?

Alignment with competence-based curriculum and assessment

Stakeholders broadly agreed that the progression logic (bands and proficiency levels) aligns well with established competence-based curriculum design and assessment practices, particularly within the Greek educational context. The three-tier proficiency structure was seen as coherent, developmentally informed, and compatible with outcome-oriented assessment models. This confirms that the existing progression architecture is fit for purpose and should be retained as the backbone of the Framework.

Early introduction of Data Literacy

Participants strongly advocated for the introduction of data literacy from the earliest stages of compulsory education, drawing on international evidence (e.g. PISA findings and German practice) and existing classroom realities. Stakeholders emphasized that core data concepts, such as identifying information, comparing quantities, and interpreting simple visual representations, are already present from first grade and can be addressed through simplified, visual, and exploratory activities.

Pedagogical adaptation vs. learner readiness

A key insight was that implementation challenges at early grades are less dependent on student readiness and more on educator preparedness. Stakeholders noted that young learners already interact with complex data structures through digital games and devices, suggesting that

cognitive readiness often exceeds instructional confidence. This shifts the focus of progression feasibility toward teacher professional development and pedagogical support, rather than delaying progression entry points.

Entry points and priorities of application

Despite general support for early initiation, stakeholders expressed uncertainty about the optimal starting grade, particularly regarding implementation before grade four. Divergent views emerged on whether grades 1–3 should be prioritized in initial rollout phases, reflecting concerns about pedagogical approaches rather than conceptual appropriateness. This highlights the need for clearer guidance on early-grade progression strategies, including optional phased or pilot-based implementation models.

Need for flexible progression

Participants stressed that progression logic must accommodate significant variation in learners' prior exposure to data-related competencies, especially in secondary education where earlier stages may not have been systematically addressed. This reinforces the need for non-linear and flexible progression pathways, allowing students to enter at different points without being constrained by age-based assumptions.

Primary to Secondary Education transition as a gap

A recurring concern was the lack of explicit mechanisms supporting continuity between primary and secondary education. Stakeholders identified the transition point as particularly vulnerable, with risks of discontinuity, repetition, or gaps in progression. This elevates the need for explicit bridging mechanisms, such as transition descriptors, diagnostic entry points, or alignment guidance between bands, to ensure coherence across educational levels.

Progression flexibility as a design requirement

Across discussions, flexibility emerged not as a desirable add-on but as a necessary design condition, given institutional diversity, uneven curricular coverage, and heterogeneous student populations. Stakeholders emphasized that progression logic must support adaptive implementation without undermining developmental coherence. This confirms that flexibility should be explicitly embedded and signposted within the Framework's progression guidance.

Dimension 4: Classroom Applicability

Q7. In which concrete ways could this framework be used at system level (e.g. curriculum guidance, teacher PD, quality assurance)?

Q8. What implementation pathways seem realistic, and which seem problematic?

Framework as a reference and navigational tool

Stakeholders consistently framed the Framework as most effective when used as a system-level reference instrument rather than a prescriptive classroom curriculum. Its main value lies in guiding curriculum design, professional dialogue, institutional planning, and quality assurance, while allowing adaptation at classroom level. This positioning should be explicitly reinforced, clarifying that the Framework supports navigation, coherence, and alignment rather than direct instructional scripting.

Multi-Stakeholder applicability

Participants clearly identified that the Framework addresses multiple stakeholder groups (students, teachers, school units, and leadership/administration) each with distinct needs and implementation pathways. While this multi-level orientation was seen as a major strength, stakeholders emphasized that it remains under-operationalized. This indicates a need for

audience-specific guidance sections that translate the Framework differently for educators, school leaders, teacher educators, and policymakers.

Integration into existing structures

There was strong consensus that feasible implementation depends on embedding the Framework within existing curricula, subjects, and school processes, rather than introducing it as a standalone reform. Participants stressed that data literacy is already partially present but fragmented, and the Framework's role should be to connect and strengthen existing practices through enrichment models and cross-curricular alignment, not curriculum replacement.

Teacher capacity

Across discussions, the primary barrier to classroom applicability was identified as educator capacity, not student readiness. Stakeholders highlighted difficulties related to conceptual understanding, interdisciplinary teaching, and linking tools to learning outcomes, particularly among generalist primary teachers. This confirms that professional development is the critical enabling condition, and that implementation success hinges on experiential, procedural, and pedagogical training rather than content-focused upskilling alone.

Complexity risks

While stakeholders valued the Framework's completeness, many expressed concern that its perceived complexity could deter classroom use, especially in systems characterized by limited collaboration and traditional teaching practices. Without mediation through scenarios, exemplars, and structured supports, the Framework risks remain at policy level. This signals the importance of simplifying entry points without simplifying the Framework itself, primarily through implementation tools.

Barriers for interdisciplinary implementation

Despite strong theoretical endorsement of interdisciplinary and project-based approaches, stakeholders highlighted significant institutional obstacles, including weak intra-school collaboration cultures and subject-based silos. Successful implementation was therefore seen as contingent on schools functioning as learning communities, with institutionalized collaboration and peer exchange rather than isolated teacher initiative. This implies that school-level organizational conditions must be addressed alongside pedagogical guidance.

Phased and pilot-based implementation

Participants strongly rejected immediate large-scale adoption, advocating instead for gradual, phased implementation supported by pilot projects. Piloting was seen as necessary to test feasibility, build educator confidence, and adapt the Framework to local realities before institutionalization. This reinforces the need to position pilot and incremental scaling as core implementation principles, not optional strategies.

Need for scenario-based resources

Concrete implementation examples (learning scenarios, cross-specialization tasks, and enrichment activities, etc.) were cited as essential for bridging the gap between framework and practice. The planned development of structured scenarios across domains and progression levels was seen as directly addressing classroom applicability challenges. This confirms that scenario-based resources are not supplementary but central to enabling classroom-level uptake.

Dimension 5: Ethical Robustness & Equity

Q9. Does the framework sufficiently address ethical, legal, and societal issues related to data use in education?

Q10. Are there equity or rights-based considerations that should be more explicitly addressed at policy level?

The ethical dimension

Stakeholders identified the ethical dimension as one of the Framework's strongest components, affirming that it sufficiently foregrounds ethical, legal, and societal issues related to data use in education. Ethics was framed as a foundational pillar that differentiates the Framework from purely technical competence models. But stakeholders identified specific ethical issues that require clearer and more explicit articulation, including data ownership, consent and permissions, personal data protection, responsible data representation, and the implications of artificial intelligence for data use.

Data Literacy as a foundation for active and critical citizenship

Participants consistently articulated a strong conceptual link between data literacy and active citizenship, positioning critical data engagement as essential for democratic participation in data-saturated societies. Uncritical consumption and reproduction of data-based content particularly in social media contexts were cited as urgent societal risks that the Framework directly addresses. This alignment with European policy priorities reinforces the need to explicitly frame data literacy as a civic competence, an educational or technical one.

Equity as policy dimension

Discussion revealed equity to be a major concern. Participants stressed that equity must be addressed explicitly at policy level, as unequal conditions fundamentally shape the feasibility and fairness of framework implementation. This suggests the Framework should make equity considerations more visible and explicit, particularly in implementation guidance.

Different levels of infrastructures as barrier

Stakeholders identified technological infrastructure disparities between schools as a decisive equity issue, noting that common outcome expectations are unrealistic where basic equipment is lacking. Detailed examples illustrated stark contrasts between well-equipped schools and those with minimal or non-functional resources, sometimes within the same administrative region. This highlights the necessity for differentiated implementation expectations and supports, aligned with infrastructural realities.

School leadership as mediator

Participants observed that infrastructure inequality is influenced not only by regional conditions but also by school leadership capacity, including priorities, resource mobilization, and engagement with external support mechanisms. This positions leadership development as a key equity lever, suggesting that equity-oriented implementation must address leadership capacity alongside material resources, rather than treating infrastructure as a purely technical issue.

Need for differentiated and context-sensitive implementation strategies

In response to equity challenges, stakeholders emphasized the need for flexible, context-sensitive implementation approaches, including differentiated pathways, phased expectations, and creative mitigation strategies such as inter-school resource sharing. These insights indicate that equity cannot be ensured through uniform implementation alone but requires adaptive strategies that acknowledge contextual variation while maintaining common ethical goals.

Dimension 6: Adoption & Sustainability Potential

Q11. What conditions would be necessary for this framework to achieve long-term adoption rather than short-term endorsement?

Q12. What risks might undermine sustainability at national or system level?

Sustainability

Stakeholders consistently emphasized that long-term adoption depends on formal institutional endorsement at national and system level, rather than informal or project-based validation. The Framework must be embedded within official structures (ministries, curriculum authorities, inspection bodies) to move beyond short-term endorsement. This implies that sustainability requires explicit policy anchoring, not voluntary uptake by individual schools or educators.

Engagement across various levels

Participants highlighted that sustainable adoption requires coordinated engagement across multiple levels like students, in-service teachers, pre-service teachers, school units, leadership, and advisory bodies. The Framework's relevance to all these groups was seen as a strength, but only if differentiated ownership and roles are clearly defined. Sustainability therefore depends on system-wide coherence, not isolated implementation efforts.

Curriculum integration

Stakeholders stressed that the Framework must be structurally embedded within curricula to achieve durability, with gradual integration across subjects preferred over standalone initiatives. Curriculum integration was seen as enabling incremental implementation, alignment with assessment practices, and long-term continuity. This reinforces that curriculum alignment is a sustainability mechanism, not merely an implementation choice.

Initial Teacher Education

Participants identified undergraduate teacher education programs as a decisive leverage point for sustainability, noting that future educators must graduate already familiar with data literacy concepts and practices. Without reform in initial teacher education, in-service training alone was seen as insufficient. This underscores the need for alignment between the Framework and university curricula, particularly in pedagogical departments.

Systematic professional development

A dominant theme was that long-term sustainability hinges on sustained, systematic professional development focused on procedural and experiential knowledge, rather than content transmission alone. Existing professional development models were criticized for inadequately preparing educators to enact competence-based frameworks. This signals that sustainability requires reform of professional development paradigms, aligning training with classroom enactment rather than theoretical familiarization.

Interdisciplinary collaboration

Sustainable adoption was linked to the existence of institutional conditions enabling interdisciplinary collaboration, such as timetable structures that allow joint work between subject specialists (e.g. humanities and computer science teachers). Without such structural enablers, interdisciplinary implementation was seen as unlikely to persist. This highlights that sustainability depends on organizational design, not educator goodwill alone.

School self-evaluation

Stakeholders identified school self-evaluation and quality assurance processes as powerful vehicles for embedding the Framework in everyday school practice. When data literacy is linked to school evaluation, autonomy, and improvement cycles, it becomes institutionally relevant rather than optional. This suggests that integration into evaluation frameworks can anchor long-term adoption.

Schools as learning communities

Finally, stakeholders emphasized that long-term adoption presupposes schools functioning as learning communities, where collaboration, peer exchange, and shared responsibility are institutionalized. Without this cultural shift, framework use risks remaining episodic and individual-dependent. This confirms that sustainability is as much a cultural and organizational challenge as a technical or curricular one.

Policy - Practice disconnection as a risk

Participants warned that frameworks often fail when introduced without sufficient consideration of contextual constraints, citing historical patterns of reform fatigue and policy-practice disconnection. Structural changes (e.g. removal of project-based learning, advisory role transformations) were seen as capable of unintentionally undermining adoption. This highlights the risk that theoretical soundness alone does not guarantee sustainability, necessitating context-aware implementation planning.

Fragmentation/partial integration as a risk

A recurring concern was that, without coherent integration, data literacy may remain fragmented across initiatives, training programs, and curricular references. The partial incorporation of related frameworks (e.g. DigComp, TPACK) without an explicit data literacy focus exemplifies this risk. Sustainability therefore requires intentional coherence-building, rather than additive layering of frameworks.

Closing question

What is the single most important improvement needed for this framework to function as a credible policy instrument?

Participants converged on several critical improvements:

Institutional embedding

The framework requires formal integration within national curriculum structures, teacher education programs, and continuous professional development systems to achieve credibility as a policy instrument.

Conceptual clarification

Development of comprehensive glossary and simplified practitioner version, with particular attention to foundational distinctions (data vs. information) and technical terminology standardization.

Practical implementation supports

Development of concrete teaching scenarios per domain and level, providing classroom-ready resources that bridge the gap between framework comprehensiveness and everyday teaching realities.

Professional development emphasis

Redesign of professional development programs to emphasize procedural knowledge rather than content transmission alone, with differentiation for specialist and generalist teachers.

Structural simplification

Domain consolidation to enhance usability while maintaining theoretical comprehensiveness, potentially yielding a five-domain architecture. This responds to implementation feasibility concerns identified during the workshop phases.

Pilot implementation

Phased introduction through systematic piloting prior to institutionalization, enabling iterative refinement based on empirical feedback.

Main outcomes - Teachers

From a **structural perspective**, teachers generally agreed that the Framework is coherent and well organized, but they identified conceptual overlaps between closely related domains (e.g., Representation/Visualization/Modelling and Analysis/Communication/Action) that limit classroom clarity. They recommended merging or hierarchically reorganizing adjacent domains at early stages of progression to create clearer entry points for practice. In parallel, Awareness, Ethics & Agency was unanimously recognized as essential but should be repositioned as a transversal, horizontal layer rather than a standalone domain. Both teachers and experts also rejected strict linear reading, favoring a spiral logic aligned with inquiry and project-based learning.

Regarding **domain completeness and balance**, participants agreed that the seven domains sufficiently capture the scope of data literacy, shifting the debate from *what is missing* to *what is developmentally feasible*. Teachers emphasized that technically demanding domains, particularly Modelling & Automation, are misaligned with primary education unless introduced gradually and with conceptual clarity. Teachers highlighted the need to differentiate core domains from advanced ones within a spiral and hierarchical progression, noting that such balance is inseparable from ongoing teacher professional development.

The **progression logic** became the most important area for revision. Teachers argued that age-based bands may not reflect classroom reality, where students show uneven, domain-specific development influenced by maturity and context. They recommended redefining bands as flexible pedagogical zones, narrower and separate from strict age assumptions. Proficiency levels were also considered too broad, with progress occurring within rather than between levels. Teachers suggested changes such as including sub-levels, domain-specific proficiency, and descriptors based on observable autonomy. The “Advanced” level was widely seen as aspirational rather than practically achievable in lower secondary education.

In terms of **classroom application**, the Framework was regarded as pedagogically effective when implemented selectively and gradually rather than in its entirety. Teachers identified Questioning & Problem Framing, Data Acquisition, and basic Representation as practical entry points across subjects and levels. A phased, pilot-based approach supported by clear scenarios and short tasks was deemed essential. Policymakers echoed this perspective, emphasizing alignment with existing curricula, assessment practices, and workload constraints rather than disruptive reform.

On **ethical robustness and equity**, participants expressed conditional confidence. Ethics, privacy, bias, and fairness were seen as essential but not clearly defined, relying heavily on teacher judgement. The rise of generative AI revealed new ethical issues related to authorship, transparency, and agency that remain unresolved. Inclusion was regarded as implicitly supported but not structurally assured, especially for learners with disabilities or in low-resource settings, leading to calls for clearer equity guidance and institutional safeguards.

Finally, on **adoption and sustainability**, both teachers and policymakers agreed that the Framework will only be used if it functions as a practical and flexible toolkit rather than a policy document. Clear classroom examples, teacher agency, ongoing professional development, and realistic timeframes were identified as key enablers. Major risks include ‘mechanistic’ implementation, inadequate training, and unequal school conditions, all of which could undermine both impact and trust.

Main outcomes - Policymakers/Experts

Regarding **structural clarity & coherence** stakeholders broadly agreed that the framework presents a clear, coherent, and methodologically legitimate model of data literacy for compulsory education. Its alignment with established European competence frameworks enhances policy credibility and facilitates integration into existing curricular and governance structures. The domain-based organization supports navigation and system-level communication, while cross-curricular applicability strengthens its relevance beyond Computer Science. At the same time, stakeholders emphasized that structural clarity at policy level must be complemented by enhanced conceptual documentation to ensure educator comprehension, reinforcing the distinction between framework design coherence and implementation accessibility.

For the **domain completeness & balance**, the seven domains were recognized as conceptually comprehensive and well aligned with contemporary data literacy demands. Stakeholders valued the framework’s breadth and cross-curricular ambition but identified tensions between completeness and implement ability. Concerns focused on inter-domain overlaps, technical complexity, and uneven feasibility across contexts, leading to proposals for domain consolidation or prioritization. Importantly, consensus emerged that completeness should be preserved at reference level, provided that flexible, selective implementation pathways are explicitly supported to accommodate national priorities and system capacity differences.

Regarding **bands & proficiency**, stakeholders assessed the progression logic as broadly compatible with competence-based curriculum design and assessment models. The three-tier proficiency structure was viewed as theoretically sound, yet not suitable as a rigid or linear mandate. Strong support emerged for early and horizontal introduction of data literacy, balanced by recognition of variability in readiness across age groups and systems. Emphasis was placed on flexibility, continuity between primary and secondary education, and the need for bridging mechanisms to address learner heterogeneity and uneven prior exposure within compulsory education.

At system level, **for classroom applicability & implementation pathways**, the framework was seen as most valuable when embedded within existing curricular, professional development, and evaluation structures. Stakeholders emphasized its role as a reference and navigational instrument rather than a prescriptive curriculum. Applicability was considered highest through incremental integration, scenario-based support, and alignment with STEM, inquiry-based, and project-based approaches. However, significant constraints were identified, including educator capacity gaps, limited collaboration cultures, and infrastructure disparities, reinforcing the need for phased implementation supported by institutional coordination and targeted professional learning.

The **ethical dimension** was unanimously identified as a core strength of the framework, strongly aligned with European policy priorities on active citizenship, critical thinking, and responsible data use. Stakeholders highlighted the importance of explicitly addressing legal and ethical issues such as data protection, consent, AI implications, and responsible representation. Equity emerged as a critical policy concern, particularly regarding infrastructure inequalities across

schools and regions. Participants stressed that ethical robustness must be accompanied by differentiated implementation strategies to ensure equitable access and avoid reinforcing existing educational disparities.

Stakeholders identified long-term **sustainability** as dependent on institutional ownership, curriculum integration, and sustained teacher professional development. Embedding the framework within initial teacher education, school self-evaluation processes, and quality assurance mechanisms was seen as essential for durable uptake. Risks to sustainability include fragmented implementation, limited educator preparedness, weakened advisory structures, and policy discontinuities. To mitigate these risks, stakeholders advocated phased implementation, pilot initiatives, interdisciplinary collaboration support, and alignment with international assessment frameworks, ensuring that adoption leads to systemic impact rather than symbolic endorsement.

Reflection on the National Validation Workshops

Evaluation of the Framework's Structure

The validation workshops confirmed a high level of consensus that the Data Literacy Framework presents a **clear, coherent, and methodologically legitimate structure** at both classroom and system levels. Teachers and stakeholders alike recognized the domain-based architecture as logically organized and aligned with established European competence frameworks, enabling navigation, communication, and policy-level alignment. At the same time, both groups identified **structural tensions** that affect usability, notably inter-domain overlaps, the ambiguous positioning of Awareness, Ethics & Agency dimension, and an overly linear visualization of progression that does not reflect inquiry-based or project-based pedagogies. Teachers emphasized that structural clarity at reference level does not automatically translate into classroom clarity, while stakeholders stressed that the framework's strength lies in functioning as a **reference and navigational instrument rather than a prescriptive curriculum**. Overall, the structure was judged as sound and future-oriented, but in need of **refinement through clarification, consolidation, and clearer signaling of horizontal and non-linear relationships**, rather than fundamental redesign.

Evaluation of the Framework's Content

Across both validation groups, the framework's content was evaluated as **conceptually complete and well aligned with contemporary understandings of data literacy**, encompassing technical, cognitive, ethical, and civic dimensions. The seven domains were widely recognized as capturing the full data literacy cycle and as supporting cross-curricular integration beyond Computer Science. However, teachers and stakeholders converged on the view that **conceptual completeness does not imply developmental or practical balance**. Concerns were raised regarding age-appropriateness, uneven feasibility of technically demanding domains (especially Modelling & Automation), and the absence of explicit prioritization between core and advanced domains. Both groups also highlighted **conceptual ambiguities**, particularly regarding foundational distinctions (e.g. data vs. information) and emerging areas such as artificial intelligence and big data, which were seen as under-explicit despite their growing educational relevance. Consequently, the content was judged as strong at reference level but requiring **clearer conceptual grounding, prioritization, and future proof** to support realistic implementation across diverse educational contexts.

Evaluation of the Framework's Applicability

The framework was consistently perceived as **most applicable when embedded within existing curricular, professional development, and evaluation structures**, rather than introduced as a

standalone reform. Teachers identified realistic classroom entry points, such as questioning, problem framing, data acquisition from immediate contexts, and basic visualization, while rejecting holistic or immediate implementation of all domains. Stakeholders similarly emphasized incremental, scenario-based integration aligned with STEM, inquiry-based, and project-based learning approaches. A shared conclusion was that **teacher capacity, not student readiness, constitutes the primary bottleneck** for applicability, particularly for generalist primary educators. Institutional barriers, limited collaboration cultures, subject silos, time constraints, and infrastructure inequalities, were identified as major constraints, reinforcing the need for phased implementation supported by concrete scenarios and professional learning. Overall, applicability was assessed as high in principle but **conditional on mediation through practical tools, differentiated guidance, and institutional support mechanisms**.

Recommendations for Revisions and Enhancements

The recommendations that follow derive from the systematic analysis and synthesis of teacher and stakeholder validation data in Greece and are formulated to support **targeted, design-level revisions** of the Data Literacy Framework.

Rather than proposing structural reconfiguration, they **focus on refining domain architecture, progression logic, and implementation affordances** to resolve identified issues of overlap, ambiguity, and developmental misalignment.

Each recommendation is intended to be **operationally actionable and guiding** in making precise edits that enhance conceptual transparency, pedagogical coherence, and contextual adaptability, while maintaining theoretical completeness and compatibility with established European competence frameworks.

These recommendations will be examined alongside corresponding findings from validation workshops conducted in partner countries, assessed against feasibility and applicability and contribute to the next Framework draft, which will guide the next phases of the project, e.g. learning scenarios, HE courses, TPD programs, and school pilots.

1. Reduce domain ambiguity through explicit consolidation or hierarchy

Redesign the domain architecture to remove conceptual overlap at entry levels, either by merging or hierarchically nesting closely related domains:

- Data Acquisition (DA) with Problem Framing (PF).
- Analysis & Interpretation (AI) with Communication & Action (CA).
- Modelling & Automation (MA) with Representation & Visualization (RV).

This change should apply at early progression bands, while allowing differentiation at advanced stages, so that teachers encounter fewer, clearer entry points when first using the framework.

2. Reposition Awareness, Ethics & Agency as a transversal layer

Remove Awareness, Ethics & Agency from the linear domain sequence and redesign it visually and conceptually as a horizontal overlay influencing all other domains. Replace outcome-style descriptors with guiding ethical questions (e.g. privacy, bias, responsibility, agency) linked explicitly to decision-making and action, not only to technical data processes.

3. Make non-linearity explicit in the framework logic

Revise diagrams and explanatory text to show the framework as a cycle or network, not a fixed pathway. Explicitly state that domain order may vary by subject, pedagogy, and context, and that iterative movement and feedback loops (especially in project-based learning) are expected rather than exceptional.

4. Redefine progression bands as flexible pedagogical zones

Decouple progression bands from strict age assumptions. Redesign bands as flexible orientation zones that reflect exposure and experience rather than chronology, allowing uneven, domain-specific progression. Narrow the bands (especially in primary and lower secondary) so they can support realistic classroom planning:

- Band 1 (Grade 1-2)
- Band 2 (Grade 3-4)
- Band 3 (Grade 5-6)
- Band 4 (Grade 7)
- Band 5 (Grade 8)
- Band 6 (Grade 9)

5. Introduce a preschool / early years entry point

Add an explicit early childhood / kindergarten progression entry, recognizing that questioning, categorization, comparison, and basic representation already occur before primary education. This closes the developmental gap identified at the start of the framework.

6. Restructure proficiency levels to be observable and domain-specific

Revise the Starting–Intermediate–Advanced levels by introducing sub-levels within each category, defining proficiency per domain rather than globally, and basing descriptors on observable autonomy, decision-making, and independence, not technical complexity. Explicitly frame the “Advanced” level as aspirational for lower secondary education unless strong contextual support exists.

7. Clarify core vs. advanced domains

Explicitly distinguish core domains expected for all learners (e.g. questioning, data acquisition, basic representation, interpretation) from advanced or context-dependent domains (e.g. modelling, automation). This prioritization should be visible in both domain descriptions and progression guidance.

8. Strengthen conceptual grounding and terminology

Add a concise conceptual section and glossary at the start of the framework, clearly distinguishing foundational concepts (e.g. data vs. information, representation vs. modelling). Produce a simplified practitioner-facing version that preserves conceptual integrity while reducing theoretical density.

9. Explicitly integrate AI and big data as cross-cutting concerns

Update the framework to explicitly address generative AI, automated data processes, and big data, not as standalone domains but as horizontal influences affecting data creation, analysis, representation, authorship, and ethics. Include clear ethical prompts related to transparency, bias, agency, and trust.

10. Define low-threshold classroom entry points

Explicitly identify Questioning & Problem Framing, Data Acquisition from immediate contexts, and basic Representation as recommended starting points for classroom implementation across subjects and levels. This should be stated clearly to counter the risk of technocratic or all-at-once adoption.

11. Anchor progression and proficiency through concrete scenarios

Ensure that each domain, band, and proficiency level is accompanied by short, concrete scenarios illustrating what practice looks like in real classrooms. These scenarios should function as translation mechanisms, without which progression and levels remain abstract.

12. Embed equity considerations directly into implementation guidance

Add explicit guidance on differentiated implementation for low-infrastructure contexts, including alternative pathways, role-based participation, and non-technological data practices. Avoid uniform outcome expectations where infrastructure and resources are uneven.

13. Clarify what “successful use” of the framework looks like

Provide clear indicators of meaningful engagement, distinguishing between superficial compliance and authentic pedagogical use. This reduces the risk of mechanistic or symbolic implementation and supports teacher agency and trust.

14. Design the framework explicitly as a toolkit, not a checklist

Revise framing language to reinforce that the framework is intended to be selectively used, adapted, and combined, rather than fully “applied.” Emphasize professional judgement, contextual adaptation, and partial adoption as legitimate and expected forms of use.

15. Prepare the framework for phased and pilot-based rollout

Add a short implementation note recommending pilot use, phased scaling, and iterative refinement, explicitly warning against immediate system-wide adoption. This aligns design expectations with institutional reality and sustainability conditions.

National Report Germany

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Executive Summary

This national report summarizes the outcomes of the German validation workshops conducted within the DATA-READY project. These workshops aimed to assess the coherence, content, and implementation potential of the proposed data literacy framework for compulsory education. Two workshops were held at Johannes Gutenberg University Mainz (JGU): the first with policymakers, experts, and institutional stakeholders, and second with primary and lower secondary school teachers. Together, these groups provided complementary perspectives, informing the targeted refinement and further development of the framework.

Both groups confirmed the framework's clear and coherent **structural design** at a theoretical level. Experts emphasized its cyclical structure, which enables continuous competence development through iterative engagement across age groups. However, both groups also identified inconsistencies in terminology, use of abbreviations, and the absence of a clear, comprehensive definition of "data" and its societal role as key barriers to implementation in educational settings. Participants recommended providing precise definitions, explanatory footnotes, and a concise glossary to enhance clarity and accessibility of the framework's terminology.

Participants agreed that the seven **domains of the framework** present a comprehensive and conceptually robust representation of data literacy. Nevertheless, several domains were considered overcomplex, requiring advanced mathematical knowledge, which limits practical and interdisciplinary implementation. Additionally, the lack of distinction between "learning with" and "learning from" data and redundancies within the domains were identified as structural weaknesses. Addressing these issues through conceptual streamlining and reducing overlaps and complexity was deemed essential to enhancing clarity, coherence, and educational applicability.

While the **progression logic (bands & proficiency)** was considered theoretically sound, it was deemed misaligned with the German national school structure, which includes a four-year elementary school system and school transition during Primary 2. Both teachers and experts emphasized the importance of reviewing the learning objectives within the progression bands to align it more closely with students' cognitive development and national curricula. They recommended clearly indicating where learning objectives overlap with existing curricula or educational frameworks, reducing perceived complexity and clarifying the framework's added value, thereby enhancing its adaptability and practical implementation.

The **ethical dimension** was widely recognized as a key dimension, though it requires clarity in terminology and further development. Teachers called for more precise definitions and qualitative approaches to ensure accessibility for diverse learners. Experts emphasized balancing ethical risks and benefits of data use and the need to clarify concepts such as fairness, ethics and personal data.

Sustainable implementation and classroom applicability depend on strong curricular alignment, teacher professionalization, and system-level support. Participants highlighted time, workload constraints and the lack of teachers and students' readiness as key barriers and called for targeted professional development, ready-to-use materials, and the use of open educational resources (OER). Reducing the framework's overall complexity and highlighting its connections to existing interdisciplinary frameworks and national curricula was crucial to making it an accessible, integrated tool rather than an additional burden.

Organization of the workshops

The organization of the “Expert and Stakeholder Validation Workshop” and the “Teacher Validation Workshop”, both held on the campus of Johannes Gutenberg University Mainz, was structured into three main phases encompassing conceptual planning and material preparation, communication with participants, and final logistical arrangements.

The first phase focused on the conceptual design and the first preparation of workshop materials. During this stage, initial considerations regarding the didactic design of the workshop were developed, including ideas for group discussions, sequencing of activities, and finding a suitable date and venue for the event. Invitations for potential participants were prepared, and the contents of the DATA-READY framework, as well as the survey materials, were translated into German to ensure linguistic clarity and accessibility for all participants. In addition, informed consent forms and a concise summary of the framework were developed in a first draft. These preparatory steps provided a first foundation for the subsequent organizational and communicative processes.

In the second phase, the primary focus was on communication and coordination with potential participants. The recruitment of participants was mainly based on the personal networks of the JGU DATA-READY team members. Each invitation was personalized and included all relevant event information, such as the workshop objectives, and venue details and was distributed via email. In addition, a comprehensive pre-survey was also attached to the same email in order to gather initial insights and familiarize participants with the framework. To ensure a transparent and traceable recruitment process, all responses, attendance confirmations, and cancellations were systematically documented in a central overview. In total, twenty stakeholders and experts and more than thirty teachers were invited. During this second phase, participants were informed about the event, and an overview was gained to support the final stage of planning.

Implementation of the workshop materials and logistical organization constituted the third phase. Catering was arranged, and a restaurant reservation was made for a joint evening dinner with the workshop participants. Stable Wi-Fi access was requested for the workshop rooms to support interactive and digital components of the agenda. All workshop materials were finalized and printed in advance. Each participant received a workshop folder containing the agenda, a summary of the DATA-READY framework, informed consent forms, and the evaluation survey. In addition, large-format posters visualizing the framework were produced for use as discussion stimulus throughout the workshop sessions.

Through the consecutive phases of conceptual planning, participant communication, and implementation of the materials along with logistical organization, all necessary preparations for the workshop were completed. This process enabled the events to proceed as scheduled and created the framework for the subsequent validation activities.

Implementation of the Workshops

The validation workshop, conducted on 12th January 2026 on the campus of Johannes Gutenberg University Mainz, was a one-day, face-to-face event that brought together policymakers and experts to discuss the proposed framework. The workshop was conceived as a structured forum for discussion and brought together representatives of key educational policy institutions, as well as various teacher training institutions. The objective of the workshop was to systematically review the proposed Data Literacy Framework across central validation dimensions, with the aim of gathering expert feedback on its structural coherence, completeness of content, logical progression, practical applicability, ethical implications, and potential for implementation. The experts and policymakers possessed expertise in educational policy structures and institutional

decision-making processes, as well as substantial experience in teacher education. This background ensured familiarity with structural and curricular requirements as well as with practice-related challenges. Consequently, the discussions were characterized by a wide range of institutional perspectives and took into account both theoretical-conceptual considerations and questions of practical implementation in educational settings.

The workshop with teachers took place on the campus of Johannes Gutenberg University Mainz on 13th February 2026. It brought together teachers from diverse educational backgrounds and varying levels of professional experience, with the aim of gaining a broad range of practical perspectives.

Both workshops were structured in a similar manner. They commenced with a welcome and opening session, followed by an initial presentation, two discussion phases and a reflection session:

- Welcome
 - Participant introductions
- Presentation Part
 - Project introduction
 - National results from D2.1 DATA-READY report
 - Data Literacy Framework (DLF) - Draft
- Discussion Phase I
 - Structure, content and applicability of domains
- Discussion Phase II
 - Structure, content and applicability of progression logic
- Reflection session
 - Key suggestions & recommendations for further development
 - Next steps & feedback

Presentation Part

At the beginning of both workshops, a presentation provided an overview of the project, its objectives, and the partners involved. As new participants had joined in addition to those who had already taken part in the first workshop, it was assumed that not all attendees were familiar with the project and its main objectives. This was followed by a presentation on the project's progress to date and the key outcomes from Work Package 2 (WP2), as documented in report D2.1 DATA-READY, to establish a common ground for validating the developed framework. Finally, the basic structure of the framework was presented and contextualized in relation to existing frameworks. Visualizations of the different domains and explanations of the progression logic were used to illustrate the conceptual structure.

Discussion Part - Teachers

This section presents the results of the focus group discussion with teachers on the clarity and structure of the framework, and its applicability in school practice. The discussion focused primarily on the progression, bands and proficiency levels, as well as the anticipated competences and learning objectives. The participants critically evaluated these in terms of their adaptability and suitability for the requirements of everyday school life. Aspects of curricular compatibility, national framework conditions, and everyday teaching challenges were also considered, to reflect on the opportunities and risks of long-term implementation of the framework.

Based on a qualitative thematic analysis of the focus group data, this section identifies similarities and differences in teachers' perspectives, highlighting both the strengths of the

proposed structure and areas that need to be refined for improvement. The findings from the group discussion are also compared with those from the pre-survey and added to the relevant sections where appropriate. They provide evidence-based insights that can inform the further development of the framework and ensure its long-term implementation in compulsory education.

Dimension 1: Structural Clarity & Coherence

Q1. When you look at the framework, what feels clear and usable for you as a teacher, and what feels complex or difficult to navigate?

Q2. Do the domains, progression bands, and proficiency levels work together in a way that makes sense for classroom use, or are there points where the structure feels confusing?

Overall structural clarity of the framework

Participants generally considered the structure, including its domains, progression bands and proficiency levels, to be suitable for use in schools.

Terminological consistency and use of abbreviations

Participating teachers frequently expressed concern that the terminology used (e.g., agency, bias, data pipeline) was unclear and difficult to understand due to the lack of clear definitions. As these terms are not immediately obvious, teachers may struggle to understand the framework, which can lead to misunderstandings or uncertainties. Providing clear definitions or explanatory footnotes in the text would strengthen a consistent and deeper understanding, regardless of prior knowledge. Similarly, the frequent use of abbreviations (e.g. 'DA', 'RV', 'AE' and 'MA') was regarded as a barrier to understanding, as they are difficult to comprehend without context, particularly in the first section of the Framework. This challenges teachers without prior experience in data literacy to implement the framework in their everyday work. Participants therefore strongly recommended providing a compact glossary containing short, concise definitions and explanations of abbreviations to improve the framework's long-term accessibility.

Understanding and operationalization of the term "data"

Several participants emphasized the need for a clearer, more operational definition of the term "data". They argued that the definition provided in the introduction is easily overlooked and is neither precise nor comprehensive enough. Consequently, there is a risk that teachers may have different or simplified understandings of data. For instance, questions were raised as to whether it refers exclusively to digital data or also encompasses images, pictograms, and other formats. Providing a clear and comprehensive definition would facilitate the application of the framework. Without this clarification, the intended competences may only be implemented in part, particularly at primary level as digital data is barely used.

Critical reflections on the framework's restriction to grades 1–9

Teachers noted that the framework is limited to Grades 1–9, raising questions about the implementation of data literacy beyond these grades. They emphasized not all learning objectives may be fully achieved by the end of Year 9, and education in Germany often continues beyond this.

Dimension 2: Domain Completeness & Balance

Q3. Taken together, do the seven domains capture what data literacy should realistically mean for students in compulsory education?

Q4. Are any domains overlapping, missing, or too dominant compared to others from a teaching perspective?



Completeness and relevance of the domains for strengthening data literacy

Teachers confirmed that the framework provides a comprehensive overview of data literacy and covers all the necessary competences related to the concept of data literacy. The completeness of the domains was highlighted as theoretical sound, even though the practical implementation still needs further refinement.

Handling imperfect data

It was suggested to focus more on dealing with incomplete or inaccurate data sets. This would enable learners to identify sampling issues or missing values, apply corrections, and prepare for real-world data challenges while fostering critical reflection.

Prerequisites for mathematical competences: Distinguishing core and advanced domains

Teachers criticized the fact that some areas require advanced mathematical skills from both students and educators. It cannot be assumed that everyone possesses these abilities without additional training programs or subject-specific professionalization. While this does not undermine the theoretical ambition of the framework, it raises questions about interdisciplinary implementation. It was suggested that core domains and competences for interdisciplinary implementation should be distinguished from those intended for specific subjects. For example, Modelling & Automation was identified as a domain particularly suitable for STEM subjects.

Suitability of individual domains for different age groups

Participants repeatedly noted that some domains were not suitable for lower grades, as they did not align with the abilities of children in those age groups. Teachers could not imagine how these competences could be applied in practice. The domain Automation & Modelling was frequently mentioned, as students often lack the fundamental competences and knowledge required to achieve the learning objectives.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. Does the progression from Primary 1 to Lower Secondary reflect how your students actually develop data-related skills over time?

Q6. Do the proficiency levels (Starting–Intermediate–Advanced) help you understand expectations, or do they risk being confusing or unrealistic?

Structural problem in levels and national educational systems

Teachers noted that the proposed progression bands do not align with the transitions in the German education system. In Germany, students typically move from primary school to secondary level after fourth grade, which involves a change of schools. Within the framework, however, this transition would occur midway through the second year of Primary 2, resulting in a discrepancy. Participants acknowledged that full alignment may not always be feasible due to international collaboration across diverse national education systems. They emphasized the need for sufficient flexibility within Primary 2 to accommodate students' varying prerequisites following school transitions. If the framework provides the necessary flexibility to address school changes and diverse learner needs, adaptation to the German system could be feasible.

Alignment of learning objectives with learner development and school types

Participants observed that certain learning objectives are insufficiently aligned with learners' developmental stages. This misalignment hinders practical classroom implementation and can lead to frustration among both teachers and students. Greater differentiation and age-appropriate formulation of objectives thus appear necessary.

Need for more differentiation

Teachers noted that the progression bands and proficiency levels do not provide sufficient differentiation for all learners across all domains, particularly since prerequisite competences can vary significantly (e.g., across different school types).

Continuation in upper secondary

During the discussion about the progression logic, participants also raised the question of what follows after grade 9, asking whether the framework extends to upper secondary levels or vocational education. They also noted that certain competences and learning objectives currently positioned in grades 7–9 would be more appropriate for advanced grade levels, suggesting that an extension would be beneficial.

Dimension 4: Classroom Applicability

Q7. If you were asked to start using this framework next school year, where would you realistically begin?

Q8. What aspects of the framework feel most practically useful, and which feels hardest to apply in everyday teaching?

Implicitly implemented components of the framework

Teachers mentioned that the Framework already incorporates content from existing curricula on an implicit level, which becomes particularly evident when analyzing the learning objectives. Participants were able to connect the framework to their own classroom experiences, recognizing familiar elements within the domains that facilitate straightforward implementation. They suggested marking these elements and connections directly within the framework.

Structural and curricular constraints

Limited time resources, alongside rigid and content-overloaded curricula, present substantial challenges to integrating the framework, particularly when perceived as an additional rather than integrated component of instruction. Under these conditions, teachers struggle to embed relevant content sustainably and systematically into their teaching practice.

Teacher's lack of data literacy

Discussions repeatedly highlighted that many teachers currently lack the required data literacy competences and are therefore unable to effectively apply the framework in their teaching practice. Without systematic teacher training programs, implementation remains fragmented at the level of individual teacher competence.

Need for objectification through scenarios & different subjects

Teachers frequently emphasized the need for examples of learning content and competences from the various domains, suitable for direct classroom use. Such examples would facilitate the framework's adoption and practical implementation. Participants particularly requested illustrations for non-STEM subjects such as languages, music, and art, to demonstrate how data literacy can be integrated and applied. Without them, interdisciplinary implementation beyond STEM subjects would be nearly impossible.

Dimension 5: Ethical Robustness & Equity

Q9. How confident would you feel using this framework to address issues such as privacy, bias, fairness, and responsible data use with your students?

Q10. Does the framework support inclusive practice for diverse learners, or are there areas where equity needs to be more explicit?

Limited consideration of neurodiverse learners within the framework

One participant highlighted that the framework's strong mathematical and numerical orientation disadvantages neurodiverse learners, such as those with dyscalculia. The emphasis on quantitative skills and abstract computations risks excluding students who struggle with numerical processing, thereby limiting their access to core data literacy competences. Incorporating alternative, creative visual or qualitative pathways would better accommodate diverse cognitive profiles and promote equitable participation.

Clarifying data's power and responsibility

Participants emphasized the framework should explicitly address the social power of data and associated responsibilities, particularly its potential to reinforce or reduce social inequalities. Understanding the role of data in society is crucial for educating informed and empowered citizens. At this point in the discussion, the focus returned to dealing with false or misleading data, like already mentioned above.

Superficial treatment and lack of clear definitions for terms

Although participants recognized the prominent position of terms "ethics" and "fairness" within the framework, the criteria for ethical action and fair data practices remain unclear. Participants noted that this superficial treatment without clear actionable definitions hinders meaningful engagement of ethical dimensions.

Dimension 6: Adoption & Sustainability Potential

Q11. What would make this framework something you actually use, rather than another policy document?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Emphasis on practical exemplification

Participants repeatedly highlighted the need for concrete examples to illustrate the practical application of the learning content. Such examples would make data literacy more tangible and facilitate its implementation in the classroom. At the same time, they would bridge the gap between the theoretical structure and everyday teaching practice.

References to existing practice

Participants noted that several learning objectives within the framework had already been integrated into daily practice, particularly in mathematics and STEM subjects. They regarded this overlap as a valuable opportunity for long-term implementation, as it facilitates adoption by building familiar structures, provided that these connections are made visible.

Lack of teacher's competences and need for teacher training

Participants discussed the need for teacher professionalization many times during the discussion and identified it as a key point for the successful implementation of data literacy. They highlighted teachers' lack of data literacy, which hinders their ability to integrate it into instruction. They regarded targeted, sustained professional development as key to establishing these competences and ensuring consistent implementation, regardless of individual capabilities. Participants suggested short, practical training courses accompanied by handouts, checklists, and regular information resources such as newsletters with new ideas and examples. These materials would provide ongoing support and guidance, helping teachers refine their instructional practices effectively. Such structured support is seen as vital for bridging competence gaps and ensuring long-term implementation.

Time limitation and perception as additional workload

Time emerged as a decisive factor for many teachers. When implementing data literacy is viewed as an additive rather than integrative component, the framework risks being perceived as extra workload, turning data literacy into a sporadic add-on rather than a fundamental part of compulsory education.

Stronger guidance in non-STEM subjects

Several participants pointed out that implementation is more challenging in language and humanities subjects, where the connection to data literacy is less obvious. This underscores the need for subject-specific teacher training and ready-to-use classroom materials.

Barriers in cooperation and internal school coordination

Another central issue is the lack of coordination within teaching teams. Teachers noted that this absence of alignment hinders the implementation of interdisciplinary approaches and the systematic coverage of all framework domains. Consequently, implementation becomes inconsistent and heavily dependent on individual educators' engagement. Transitions between school types and teacher changes were viewed especially critically because these phases often lack binding agreements that extend beyond core curricular competences to include data literacy aspects, ensuring continuity and seamless progression.

Structural requirements in schools

Participants noted that some schools lack the adequate digital infrastructure presupposed by many learning objectives in secondary I. This deficit limits the ability to achieve higher-level learning objectives that depend on technology. Participants emphasized that without sufficient digital infrastructure, the practical implementation of these competences is still limited.

Closing question

If you could change one thing in the framework to make it more useful for teachers, what would it be?

Need for clearer definitions of key terms

Participants emphasized the need for clearer and more operational definitions of the framework's key terms and concepts, primarily the terms "data", "ethics", and "agency". The concept of data was seen as especially vague. Similarly, teachers felt that the societal role of data, along with its impact on inequalities and power dynamics, was insufficiently highlighted. Having precise, easily accessible definitions within the framework would foster a shared understanding among teachers and minimize misinterpretations, particularly among those without a comprehensive background in data literacy.

Provision of application examples, including differentiation and subject-specific adaptations

Teachers repeatedly called for concrete application examples demonstrating how the competences and learning objectives can be implemented in real classroom situations. They particularly emphasized the need for differentiated examples addressing varying performance levels and offering adaptations for different subjects, including non-STEM areas such as languages, arts, and music. Such materials would lower the entry threshold and support more consistent, inclusive implementation across classes and school types.

Use and consistency of abbreviations

Participants also highlighted the need for more careful and consistent use of abbreviations throughout the framework. Many abbreviations were not immediately clear and sometimes appeared without prior explanation, hindering reading and understanding. They recommended



using a uniform convention supported by a glossary and introduced once in every chapter to ensure that all abbreviations are defined and used consistently.

Discussion Part – Policymakers/Experts

This section presents the results of the group discussion with experts and decision-makers from education policy and administration. The discussion focused on the framework's conceptual coherence and systematic structure, as well as its potential application in political and administrative contexts, particularly regarding teacher training, curriculum development, and quality assurance. Participants engaged intensively with the framework's domains, progression bands, and proficiency levels, assessing their transferability to existing continuing education structures and curriculum development processes. Additionally, issues of institutional anchoring and integration into national education strategies were discussed to identify key conditions and factors for successful implementation.

Based on a qualitative thematic analysis of the discussion data, this section outlines both converging and diverging perspectives. It highlights the framework's opportunities for promoting coherence between educational governance and school practice, as well as existing challenges concerning feasibility, resource requirements, and national suitability. The results provide evidence-based guidance for policymaking and the strategic further development of the framework within systemic education reforms.

Dimension 1: Structural Clarity & Coherence

Q1. From a system or policy perspective, does the framework present a clear and coherent model of data literacy for compulsory education?

Q2. Is the internal logic between domains, progression bands, and proficiency levels appropriate for use as a reference framework?

Overall structural clarity of the framework

Participants generally regarded the framework as well-structured with an understandable underlying logic. The domain structure, progression bands, and proficiency levels were seen as an adaptable foundation for school implementation.

Unclear objectives of the domains (e.g. Communication & Action)

Some participants noted that the overarching objectives of certain domains, particularly in *Communication & Action*, were not clearly recognizable. Questions were raised about whether data literacy should focus primarily on school learning, social participation, employability, or preparation for higher education. This lack of clarity complicates the contextualization of the framework within comprehensive school education for experts and policymakers.

Terminology of the framework

Participants noted that some terms used in the domains could be perceived as overly abstract or as “buzzwords,” particularly by teachers of lower grades. This level of abstraction could hinder the development of concrete teaching activities aligned with the framework's competence requirements. As a result, implementation risks being limited primarily to grades 8 and 9.

Need for clearer definition of the term “data”

Several participants emphasized the need for a clearer, more precise definition of “data”. They noted that the definition in the introduction is easily overlooked and lacks sufficient precision and comprehensiveness. This could lead teachers to adopt divergent or overly simplified understandings of data, resulting in the partial implementation of the intended competences. One participant suggested adding examples of data types within the individual domains and

competency descriptions. This would clarify the term, prevent misunderstandings, and support the consistent and targeted implementation of the competences. Experts and policymakers critically noted that the current draft of the framework does not include qualitative data and remains primarily quantitative.

Missing inclusion of grades 10–13

One participant questioned the decision not to extend the framework to include grades 10 through 13. They believed that including these grades was particularly relevant because certain competences, such as comprehensive data analysis, are usually developed in upper secondary education. From a systemic perspective, the exclusion of this level was seen as neglecting advanced learners, especially since data literacy is a key competence for older learners too, enabling them to become informed and responsible citizens.

Limited attention to the societal role of data

Participants indicated that the framework lacks an explicit reference to the social role of data. This aspect of data literacy is important for compulsory education and would add significant value to the framework. In their view, data literacy should not be reduced to technical aspects or data protection issues but should also encompass the social, ethical, and political dimensions of data. It was questioned whether there are other challenges and problems, beyond data protection, that are relevant for learners when dealing with data (e.g., power relations, decision-making processes, social impacts of data-based systems). These should be addressed and positioned more strongly in the framework.

Clarity on curricular integration

Participants questioned whether the framework should be an additive or integrated component of existing curricula. It remained unclear whether data literacy should be embedded within the existing competences and areas of the existing syllabus or be taught separately. This requires clearer articulation because the decision significantly impacts the feasibility of implementation.

Dimension 2: Domain Completeness & Balance

Q3. Do the seven domains together provide a complete and balanced picture of data literacy at system level?

Q4. Are any domains insufficiently developed, overly complex, or misaligned with current policy priorities?

Coherence and cyclic structure of the domains

Overall, participants described the framework as clearly structured and comprehensible. They confirmed understanding of its underlying logic and characterized the seven domains as a coherent, interconnected concept. One participant highlighted the framework's circular structure, noting that it fosters continuous development of attitudes, perspectives, and critical questions when engaging with data. Another described this process as "a very meaningful, extended evaluation cycle" and emphasized that the circularity promotes ongoing reflection and further development.

Domain Modelling & Automation

The domain Modelling & Automation was discussed ambivalently. Participants emphasized that this domain covers key aspects, such as computational thinking and algorithmic concepts, which are often underrepresented in the German educational system (e.g., ICILS). Thus, it fills a gap in current compulsory education. However, many teachers lack the necessary competences to effectively promote this domain, necessitating targeted training programs.

Appropriateness of competences

Participants expressed concerns about the suitability and accessibility of several competences associated with their respective domains. Although the competences in Data Acquisition & Management, Representation & Visualization, and Analysis & Interpretation were considered technically correct, they were deemed more suitable for higher education than for grades 1-9. These competences and learning objectives were noted for their strong mathematical focus, making certain competences difficult to achieve without advanced mathematical knowledge. Participants therefore recommended critically reviewing the competences considering learners' cognitive prerequisites across all grades and adapting them as needed.

Clarity of terminology

Experts and policymakers considered the terminology used to describe the domains and competences to be clear and comprehensible. Few terms were identified as lacking clarity. In particular, the concept of fairness used in the context of Awareness, Ethics & Agency was perceived as unclear, leading to questions about its intended meaning. Participants discussed the extent to which the term "fair" can be clearly defined in the context of data, and which criteria could be used to distinguish between fair and unfair data practices. Participants suggested that the term should be redefined to avoid subjective assessments of fairness.

Missing distinction between "learning from data" and "learning with data"

One participant mentioned that the framework does not distinguish between "learning from data" and "learning with data", emphasizing that this distinction is pedagogically significant, encompassing two complementary objectives: developing skills for handling data (learning from data) and using data to support subject-specific learning processes (learning with data). A clearer separation of these perspectives would enhance the framework's didactic precision and practical applicability.

Redundancies and overlaps in competences

In reviewing the competences within the framework participants identified several redundancies and overlaps. For instance, working with spreadsheets was also suggested as a subcategory of data visualization, as tabular representations can also be viewed as a form of visual data display. They recommended systematically reviewing the entire set of competences. Redundant or overlapping elements should be consolidated or removed to enhance the framework's coherence and clarity and reduce its complexity.

Complexity and practical feasibility

Participants perceived the framework as too complex for teachers to implement in practice. The large number of competences and the level of detail in domain descriptions were seen as barriers for implementation in the educational settings, as teachers would consider the framework to be an add-on and "overwhelming". Participants therefore recommended a systematic review of the framework to reduce redundancies, ensure relevance and simplify the framework's structure.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. How well does the progression logic align with curriculum design, learning outcomes, and assessment practices in your context?

Q6. Is the progression flexible enough to accommodate national and institutional variation?

Fit between framework progression logic and curricular structures

Participants emphasized that the proposed classification of the progression bands does not align with transitions within the German education system. In Germany, the transition from primary to

lower secondary education typically occurs after the fourth year of primary school and involves changing school type. According to the framework, students would therefore change schools within Primary 2. The participants acknowledged that a complete fit will not always be possible due to international cooperation with different national school systems. However, they emphasized that fundamental adjustments to the German school system are feasible, if the framework provides sufficient flexibility to accommodate school changes and the diverse learning needs of students.

Age appropriateness of learning objectives

Participants raised concerns that the framework assigns certain learning objectives to younger age groups than is typical in educational practice. For instance, the use of calculators is intended for Primary 2 (grades 4–6), even though in Germany they are usually introduced in grade 7. Additionally, some learning objectives were considered too complex or overly mathematical, particularly if necessary mathematical foundations lacking. Particularly, Modelling & Automation could realistically be introduced from grade 9 onwards. Participants also highlighted issues with terminology, noting that the term "algorithm" is still unfamiliar to students in grades 7–9. This makes it even more difficult to implement this domain in younger grades. The participants recommended reviewing the learning objectives to ensure their alignment with the learners' cognitive and emotional abilities and adjust them, if necessary.

Gaps between proficiency levels and differentiation challenges

Participants critically reflected on the framework's progressions regarding their suitability and adaptability. They observed that the gaps between several proficiency levels are too wide, making certain transitions overly demanding. In Awareness, Ethics & Agency, for instance, the shift from a basic understanding of data protection and compliance with established rules to recognizing bias and discrimination in data sets and implementing fairer data practices requires a much deeper understanding of working with and collecting data than learners may yet possess. This issue also poses challenges for teaching practice, particularly in terms of internal differentiation. Teachers need to accommodate varying competence levels within a group and tailor instruction accordingly. However, the broad range of requirements across levels limits this flexibility, making truly differentiated teaching difficult to realize.

Internal logic of learning objectives

One point of discussion focused on the internal logic of the learning objectives across progression bands and proficiency levels. Some participants noted that the learning objectives are not always built on one another and, in some cases, can be achieved independently. At the same time, questions were raised as to whether a strict hierarchical structure is necessary at all or if learning objectives can function effectively as independent learning objectives.

Comparison with existing curricula

Participants emphasized that the framework's content should be systematically compared with existing curricula and other established cross-curricular reference frameworks. This comparison should clearly indicate which elements are already covered and identify areas where the framework introduces genuinely new content.

Suggested refinements for future development

One participant proposed that the framework could be further developed by introducing specializations or subject-specific profiles. For example, a STEM-focused profile could place greater emphasis on statistical reasoning, while other profiles might address the distinct requirements of humanities or social sciences. These approaches would make it possible to align

the learning objectives more closely with the specific needs of different school contexts and teacher training programs, thereby increasing both their relevance and practical applicability.

Dimension 4: Classroom Applicability

Q7. In which concrete ways could this framework be used at system level (e.g. curriculum guidance, teacher PD, quality assurance)?

Q8. What implementation pathways seem realistic, and which seem problematic?

Integration into existing educational structures

Participants proposed a realistic implementation strategy that focuses on connecting the framework to existing curricula and similar educational structures. They emphasized that aligning the framework with established systems is crucial for ensuring coherence and facilitating teacher acceptance, as it enables educators to build on familiar reference points. Any additions should be limited to genuinely new and valuable elements. From a scientific view, the conceptual design of the framework was generally considered as theoretical sound. However, due to its broad scope, it was noted that the framework is way too extensive for routine school practice and could therefore only be implemented in parts (see Question 11).

Dimension 5: Ethical Robustness & Equity

Q9. Does the framework sufficiently address ethical, legal, and societal issues related to data use in education?

Q10. Are there equity or rights-based considerations that should be more explicitly addressed at policy level?

Missing definition and inappropriate examples of personal data

Participants discussed the definition and examples of personal data used in the progression bands of the domain Awareness, Ethics & Agency. For instance, referring to names in the context of data protection at level 1 of primary was considered inappropriate, while addresses or photos were suggested as more suitable alternatives. It was recommended to review the examples used and developing a revised definition to clarify which types of data should be regarded as requiring protection. Furthermore, participants emphasized the importance of context when determining the sensitivity of personal data: for example, sharing one's address may be legitimate in an emergency but inappropriate in a public setting. This contextual distinction as well as a clear definition of personal data is not yet reflected in the current version of the framework.

The need for a more balanced perspective on data use

Participants emphasized the necessity for the framework to evolve beyond a predominantly risk-oriented perspective, promoting instead a more balanced understanding of data usage. While awareness of privacy risks and ethical challenges is still important, learners should also recognize the positive potential of data when it is used responsibly and transparently. Highlighting examples from areas such as medicine, environmental protection and education could illustrate how data-driven insights contribute to solving societal challenges. Adopting this broader perspective would encourage learners to protect data and actively engage in shaping ethical, innovative and beneficial forms of data use.

Emphasizing the societal role of data

Participants noted that the role of data in society should be highlighted to promote teachers and policymakers' understanding of its social implications and potential to amplify inequalities. Adopting this perspective would also make data literacy and the associated framework more relevant in compulsory education (see Q1/2).

Dimension 6: Adoption & Sustainability Potential

Q11. What conditions would be necessary for this framework to achieve long-term adoption rather than short-term endorsement?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Ensuring transparency of compatibility with existing models and frameworks

There was considerable discussion about the framework's compatibility with existing models and structures, such as DigCompEdu. Participants emphasized that a transparent comparison and compatibility check with established competence frameworks and curricular guidelines is essential. They pointed out that several elements of the framework overlap with content already covered in existing curricula or broader competence models, like cross-curricular frameworks. Therefore, a concrete representation of this connection should be included directly in the framework. This would clarify its supplementary nature, reduce its perceived complexity, and help teachers understand how to integrate it into their classrooms without creating additional, parallel structures or deviating from the curriculum. It would also clarify where the framework extends beyond existing models and where additional teaching units may be necessary.

Create a clear distinction from data protection

Participants emphasized the need to draw a clearer distinction between the framework and existing data protection initiatives, as numerous concepts and teaching materials already address this topic. The framework should explicitly highlight where it extends beyond data protection, for instance by addressing the broader phenomenon of the datafication of society and therefore the need for data literacy. Without such differentiation, the framework will be perceived merely as another data protection tool and therefore regarded as redundant.

Use of supporting structures

The use of Open Educational Resources (OER) and the development and testing of classroom assessments were identified as valuable strategies for supporting practical implementation. Such approaches can help identify learners' specific needs, provide evidence-based insights, and ensure that the framework's application in schools is both targeted and effective.

Risk of being perceived as an add-on

The feedback indicated that the framework's long-term implementation depends on its clear positioning in relation to existing models, stronger curricular integration, transparent communication of its added value, and the provision of practical support services for educators. Without these measures, the framework risks being perceived as an additional or isolated instrument rather than an integral component of educational practice.

Risks to sustainable implementation

The primary risk to the framework's sustainability lies in the potential perception that it constitutes an addition to existing systems, particularly if its compatibility with current curricula and competence models is not made explicit. Moreover, the framework's ethical implications and conceptual distinctions must be clearly articulated to avoid redundancy and enhance its legitimacy within the broader educational context.

Structural preconditions and the need for teacher training

Participants also highlighted structural limitations as key challenges to successful implementation. Time constraints and teachers' limited expertise in several areas for example data analysis and interpretation, were seen as significant barriers. Without targeted professional development, sustainable implementation of the framework is unlikely. Overall, the feedback

underscored that insufficient curricular integration, lack of time, and limited professional support for teachers constitute crucial risk factors that could impede the framework's long-term establishment at national or systemic levels.

Closing question

What is the single most important improvement needed for this framework to function as a credible policy instrument?

Reducing complexity

According to the participants, the most important improvement needed is to substantially reduce its content, primarily by removing redundancies within the competences. They emphasized that the framework's current extensive scope and level of detail risk overwhelming teachers in practice. The large number of competences and overlaps make it difficult to navigate and time-consuming to establish meaningful connections to classroom teaching. Without significant streamlining, the framework would be perceived as too complex and would not be accepted for everyday use in schools.

Compatibility with existing competence models and curricula

Participants also highlighted the need for a systematic review of the framework's compatibility with existing competence models and curricula, alongside transparent documentation of these connections. This would clarify which aspects are already covered in curricula and where the framework provides additional perspectives, helping teachers to integrate it more easily and avoid creating parallel structures.

Age-appropriateness of domains and learning objectives

Additionally, they stressed the importance of reviewing the feasibility of the content in relation to different year groups. Competence should be assigned in a realistic and age-appropriate way, both to avoid overburdening students and to support the gradual development of competence. Overall, participants concluded that reducing the content, aligning it more clearly with the curriculum and structuring it in an age-appropriate way is essential to ensure the framework's practical applicability and credibility as an educational policy instrument.

Main outcomes - Teachers

Participants considered the **framework's overall structure**, including domains, progression bands, and proficiency levels, to be suitable for school use. However, concerns were raised about terminological consistency and the frequent use of abbreviations, as these could hinder understanding and implementation. To improve accessibility, clear definitions, explanatory footnotes and a concise glossary were recommended. Participants also emphasized the need for a more precise, operational definition of "data" to ensure consistent understanding and proposed for a more prominent position within the framework. Teachers also criticized that the framework is limited to Grades 1–9, which could result in data literacy not being systematically addressed in upper secondary education and leave gaps in learners' competences.

Teachers acknowledged that the framework's **domains** provide a comprehensive overview of data literacy and cover all the necessary competences. They also noted that certain domains are too complex to implement in practice and require advanced levels of mathematical knowledge from both teachers and learners. This raised concerns about interdisciplinary implementation and led to the idea of assigning certain domains (e.g. Modelling & Automation) to specific subjects. Participants also pointed out that some areas may not be suitable for younger learners, limiting their applicability in the lower grades.

Teachers emphasized that the **progression bands** in the framework do not fully align with national school transitions. They emphasized the need for flexibility to accommodate the German school system, with its four-year elementary school and the change of schools within Primary 2. They also felt that the progression bands and proficiency levels were not differentiated enough for diverse learners or different school types and that some learning objectives were more appropriate for higher grades. Participants questioned the framework's continuity beyond Year 9, again suggesting that extending it to upper secondary education would make it more relevant in practice.

In discussions about **classroom applicability**, teachers recognized implicit connections between the framework and existing curricula, which would facilitate implementation if explicitly marked. Key challenges include time constraints, overloaded curricula, and teachers' insufficient data literacy, all of which limit systematic integration. Concrete examples are needed to enable interdisciplinary application (especially for non-STEM subjects such as languages, music, and art).

Regarding the dimension of **ethical robustness and equity**, participants highlighted that the framework's strong quantitative focus may disadvantage neurodiverse learners. They recommended including alternative visual or qualitative pathways to ensure equitable participation. They also emphasized the need to address the social power of data and the associated responsibilities, including how to handle misleading data. Finally, participants noted that terms such as "ethics" and "fairness" are not clearly defined, which limits meaningful engagement with the ethical dimensions of data literacy.

During the discussion about the **adoption and sustainability** potential of the framework, participants emphasized the importance of providing concrete classroom examples to make the framework tangible and facilitate its practical implementation. They noted that some learning objectives already align with existing teaching practice, particularly in STEM subjects, which could encourage its adoption. However, limited data literacy among teachers and time constraints were identified as significant barriers, highlighting the need for targeted professional development, supporting materials and subject-specific guidance, particularly in non-STEM subjects. They also identified coordination within teaching teams, across school transitions and digital infrastructure as crucial for long-term implementation. Without this, the framework risks being perceived as an additional workload rather than an integral part of compulsory education.

Main outcomes - Policymakers/Experts

Participants assessed the **structure of the framework** as logical, clear, and coherent on a theoretical level. The modular structure in domains, progression bands, and proficiency levels was considered adaptable to national contexts. Participants emphasized the cyclical structure, as it promotes the repetition and consolidation of competences in different contexts and across all age groups. Participants identified two key missing elements: a comprehensive and operational definition of "data" and an explicit reference to the social role of data in society. They emphasized that both are essential for fostering a consistent understanding of data literacy and for enabling learners to critically engage with data shape decision-making, power structures, and social participation.

The conceptualization of data literacy across the framework's **domains** was widely regarded as comprehensive and theoretically robust. Participants noted that the distinction between "learning with data" and "learning from data" was missing and should be integrated into the framework. Furthermore, redundancies and overlaps within the associated competences were criticized. Participants suggested that these should be systematically reduced to enhance clarity, increase coherence, and improve usability. Overall, although the framework was considered

theoretically robust and comprehensive, participants repeatedly emphasized that its current level of complexity makes it seem too demanding and potentially overwhelming for practical implementation.

The participants generally accepted the structure of the domains into **progression bands** and their differentiation into proficiency levels. However, discussions repeatedly emphasized the need for a critical review of the learning content within the progression bands, with the aim of aligning it more closely with students' cognitive development and existing national structures. Furthermore, participants emphasized that learning objectives should clearly indicate where content is already covered in the national curriculum or other established cross-curricular frameworks. Such cross-referencing would reduce the perceived complexity and volume of *new* content by clarifying which elements are genuinely additional. According to the participants, this would substantially enhance the framework's adaptability and facilitate its practical implementation.

Participants highlighted three key points regarding the **ethical dimension** of the framework. Primarily, the definition of personal data requires clarification, and the examples used in the learning objectives must be critically reviewed to ensure they are appropriate for the different stages of education. They also emphasized the importance of contextual sensitivity, noting that certain data may be legitimate to share in specific situations but not in others. Secondly, the framework should adopt a more balanced approach to data use, acknowledging both the ethical risks and the positive potential of responsible and transparent data practices. Examples from fields such as medicine, environmental protection and education could illustrate these benefits. Finally, the societal role of data should be emphasized to help teachers and policymakers understand its social implications, including its potential to reinforce inequalities. This would increase the framework's relevance for school education.

Participants emphasized that the framework's potential for **adoption and sustainability** depends on its transparent alignment with existing curricula and competence models. This would clarify which elements are already being implemented in everyday school life, reduce the perceived complexity and support the framework's long-term implementation in educational settings. Furthermore, experts emphasized that the framework must position itself beyond data protection in terms of ethical and critical considerations. Otherwise, it would lack sufficient value and be seen merely as an additional data protection initiative. The framework should adopt a broader perspective on the societal role of data and clearly illustrate its relevance in this context. Furthermore, participants suggested using existing materials, such as Open Educational Resources (OERs), to support the long-term implementation of the framework. Key barriers include limited curricular integration, inadequate teacher training, time constraints and the risk of the framework being perceived as an additional rather than embedded component of educational practice.

Reflection on the National Validation Workshops

Evaluation of the Framework's Structure

Both experts and teachers considered the overall structure to be clear, coherent, and theoretically sound. Experts emphasized the cyclical organization of the domains, highlighting its potential to support iterative learning processes and enhance sustained competence development. They also assessed the structure of the domains, progression bands, and proficiency levels as appropriate for a European competence Framework. Nevertheless, participants emphasized the need to consider the structural specificities of the German education system, particularly its four-year primary education phase, which contrasts with the six-year models prevalent in other European contexts. They advised introducing more flexibility



in the Primary 2 progression or otherwise revising the progression logic at all. Additionally, both experts and teachers identified structural challenges affecting practical implementation. These include overlaps and redundancies between domains and the age-appropriateness of some domains. Discussions therefore addressed the potential differentiation between core and advanced domains, as well as the subject-specific attribution of domains with strong technical or mathematical focus. Overall, the framework's structure was assessed as theoretically clear and coherent, while its practical implementation in educational settings will require further adaptation.

Evaluation of the Framework's Content

Participants in both workshops rated the framework as a conceptually comprehensive and theoretically well-founded model that systematically addresses the core competences of data literacy. One major point of discussion and criticism among teachers and experts was the incomplete and imprecise definition of "data", as it remained unclear which types of data were included and what could be considered "data" within the framework. Additionally, the societal role of data and its broader social implications were not sufficiently emphasized (e.g. impact on inequality or power relations). Accordingly, clarifying the concept of data and embedding it more firmly within the framework were identified as key aspects for further development. Both workshops emphasized the insufficient consideration of ethical dimensions beyond data protection. The current treatment of ethics was characterized as remaining at a general conceptual level and lacking the necessary depth to enable reflective engagement in educational practice. In this context, participants identified the need for further clarification and conceptual precision in the use of terminology, especially regarding "fairness" and "ethics", since the current terminology creates ambiguity of competence expectations, increasing the risk of misunderstandings and implementation difficulties. Additionally, educators perceived the frequent use of abbreviations as hindering readability and reducing overall accessibility.

Finally, participants argued systematically reducing redundancies and content overlapping across domains and streamlining the whole framework to make it clearer, more concise, and more usable. Furthermore, they recommended reviewing the suitability of learning content within the progression regarding learners' cognitive requirements, as certain learning objectives and transitions between progression levels were considered too demanding. Overall, participants assessed the framework's content as comprehensive and sufficient for covering data literacy; however, they emphasized the need for greater terminological precision, a review of learning objectives, fewer overlaps and a more streamlined framework.

Evaluation of the Framework's Applicability

Participants repeatedly emphasized the need for a more practical, flexible and compact framework. While the framework's structure and content were considered comprehensible from an academic perspective, it was perceived as overcomplex for teachers to use in everyday school settings. Limited time resources, insufficient institutional cooperation, inadequate teacher preparation, and insufficiently developed learner competences were identified as major challenges. Given these challenges, participants considered streamlining the content and reducing the overall complexity essential to enable realistic implementation.

Furthermore, experts stressed the importance of explicitly highlighting connections to existing interdisciplinary frameworks and national curricula. Clarifying and visualizing these would prevent the framework from being perceived as an additional burden and position it as a compatible extension of existing curricular structures instead. This alignment would allow teachers to identify where elements of data literacy are implicitly integrated and how they can be meaningfully expanded. At the same time, participants expressed a need for practical examples,

especially for subjects in which applicability is less apparent, such as languages, art, and music. Additionally, they identified the need to more clearly define responsibilities for domains that require advanced skills, such as Modelling & Automation.

Overall, while the framework was evaluated as theoretically sound, it was considered insufficient for implementation in school contexts. Consequently, successful implementation was considered to depend on a stronger practical orientation, reduced complexity, and the establishment of clear support structures at institutional and professional levels.

Recommendations for Revisions and Enhancements

The following recommendations are based on a systematic analysis of data collected during the validation workshops with teachers and stakeholders in Germany and are intended to guide targeted revisions that address the identified needs and priorities. The findings support maintaining the framework's comprehensive theoretical foundation while enhancing its adaptability to everyday educational practice. The central objective is to make the framework more accessible and practical for implementation in educational settings.

The findings indicate that a fundamental restructuring of the framework, including its domains and progression logic, is not required. Nevertheless, the overall complexity of the framework should be substantially reduced through streamlining at both the structural and content levels. In addition, targeted revisions within the domains and progression logic, together with the clarification of terminology, are necessary to enhance the framework's adaptability and to support its effective implementation within educational practice.

The recommendations are presented as operationalized, action-oriented guidance for the further development of the framework.

1. Clarify and broaden the concept of “data”

Refine the definition of data to explicitly describe what data means in different contexts. Ensure that the framework recognizes quantitative and qualitative forms of data, including textual, visual, and observational data and distinguish clearly between information and data. Expanding the focus beyond numerical data enhances conceptual precision and better addresses diverse learners. The definition should be placed more prominently within the framework, as it provides a critical foundation for consistent interpretation and implementation.

2. Integrate the societal role and impact of data

Integrate the social, ethical, and political dimensions of data into the framework explicitly. To ensure a more comprehensive understanding of data literacy, it is essential to expand its focus beyond technical and data protection aspects to include power dynamics, decision-making processes, and the broader societal effects of data-driven systems.

3. Review progression in relation to learners’ cognitive development and structural requirements

Review the progression and age-appropriateness of learning objectives to ensure they align with learners’ cognitive and emotional development. Revise competences and learning objectives, particularly those in Modelling & Automation, that are introduced too early or depend on higher-level mathematics. Adapt terminology and complexity levels to reflect realistic curricular progressions and student readiness.

4. Highlight connections to national curricula and cross-curricular frameworks

Include a clear mapping to existing curricula and competence frameworks to demonstrate compatibility and reduce perceived complexity. Explicit annotations should visualize which

elements are already embedded in current frameworks or curricula and which are new, supplementary contributions, helping teachers integrate the framework without creating parallel structures.

5. Distinguish between core and advanced domains and introduce subject-specific allocation

Distinguish core competences for interdisciplinary applications from advanced subject-specific domains that require higher levels of mathematical or technical expertise. This differentiation, particularly regarding Modelling & Automation, will support realistic implementation and clarify professional development needs. Additionally, consider developing subject-specific profiles or specializations (e.g., a STEM-oriented profile emphasizing statistical reasoning) to align learning objectives more closely with students' needs and interests.

6. Reduce overlaps between domains

Review and refine all domain competences to remove redundancies and overlaps, particularly between *Representation & Visualization* and Modelling & Automation (e.g., tables as visualizations), to reduce complexity and increase adaptability.

7. Clarify the concepts of ethics and fairness and strengthen the ethical dimension

Clarify the concepts and criteria of “ethics” and “fairness” within the framework to enable meaningful engagement with these dimensions. Provide clear, actionable definitions and guidance for recognizing and applying ethical and fair data practices in educational settings and strengthen the ethical dimension.

8. Include creative forms of data visualization

Incorporate alternative and creative approaches to data visualization to address different learners' individual needs. Broadening the focus beyond traditional chart types can increase engagement, foster multiple ways of thinking, and promote more inclusive and accessible forms of data representation.

9. Moving beyond a data protection perspective

Differentiate the framework more clearly from existing data protection initiatives by emphasizing its broader focus on the datafication of society and the development of comprehensive data literacy. Promote a balanced understanding of data use by moving beyond a predominantly risk-oriented view and highlight both ethical considerations and positive applications. Illustrative examples from fields such as medicine, environmental protection, and education should be included to demonstrate how responsible data use can contribute to solving societal challenges and empower learners to engage critically and constructively with data.

10. Review transitions between progression levels and learning objectives

Review the progression structure and internal logic to ensure smoother transitions between proficiency levels and reduce too large jumps between learning objectives (e.g., in Awareness, Ethics & Agency). Consider implementing a more flexible progression model to support differentiated instruction and better reflect the diverse developmental pathways of learners.

11. Differentiate between “learning with data” and “learning from data”

Differentiate more clearly between “learning from data” (developing data-handling competences) and “learning with data” (using data to support subject learning).

12. Acknowledge the transition from primary to secondary education in Germany

Adapt the progression logic or consider enough flexibility to reflect the specific conditions of the German education system, particularly the four-year primary school.

13. Incorporate upper secondary education into the framework

Include considerations for integrating upper secondary education (grades 10–13) into the framework to provide students with a continuous and comprehensive learning pathway. Addressing this stage would acknowledge the importance of advanced data literacy competences developed in later schooling, thereby strengthening the framework’s relevance in preparing students for higher education and civic participation.

14. Provide lesson examples for non-STEM subjects

Include subject-specific application examples for non-STEM disciplines to illustrate meaningful implementation of data literacy, such as in languages, arts, and music. The examples should be designed to be adaptable to different educational contexts, subjects, and learners.

15. Rethink the examples used

Review and revise the examples used across domains and progression levels. Replace any unsuitable examples with more appropriate alternatives (e.g., replace names as personal data with addresses or photos in Awareness, Ethics & Agency). Clarify the definition of personal data and its contextual sensitivity, emphasizing that the required level of protection depends on how the data are used or shared.

16. Review the use of abbreviations

Minimize the use of abbreviations and provide clear definitions of all abbreviations used. Providing brief explanations within the text, a glossary or footnotes improves accessibility and prevents misunderstandings among teachers who are unfamiliar with the terminology or framework of data literacy.

17. Reducing complexity and streamlining the framework

To enhance clarity and practical applicability, theoretical and explanatory content essential to the conceptual foundation and internal coherence but overly detailed should be relocated to an appendix or background section.

National Report Poland

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Executive Summary

The Polish validation workshop examined the Data Literacy Competence Framework through a structured consultation process with teachers, school leaders, researchers, and education stakeholders. The validation focused on three analytical dimensions: Structure, Content, and Applicability, in line with the common D2.3 methodology. Overall, the Framework was positively evaluated as strategically relevant, future-oriented, and aligned with emerging digital and civic education priorities in Poland.

Participants confirmed that the Framework presents a **coherent and logically organized architecture** built around seven complementary domains. The structure was recognized as conceptually robust and compatible with interdisciplinary and inquiry-based approaches already embedded in elements of the Polish curriculum, particularly in mathematics, informatics, and project-based learning contexts. At the same time, stakeholders proposed targeted refinements to enhance usability and systemic integration. These recommendations focused on functional optimization rather than structural redesign.

The Framework's **content** was considered highly relevant to contemporary educational demands, including digital citizenship, AI-related competences, computational thinking, and evidence-based reasoning. Participants particularly valued the balanced integration of technical, ethical, and civic dimensions of data literacy. Teachers emphasized that **progression bands and proficiency levels** must reflect non-linear and domain-specific student development patterns observed in real classrooms.

Participants agreed that the Framework holds significant **transformative potential** at classroom, institutional, and policy levels. However, sustainable implementation requires enabling conditions at system level. Concerns were expressed regarding potential increases in teacher workload and disparities in technological readiness if implementation is not strategically coordinated.

The Polish validation findings demonstrate strong endorsement of the Framework's strategic direction and conceptual coherence. There was broad consensus that ethical awareness and responsible data use must remain central components. Participants agreed that teacher professional development represents the decisive factor for long-term success.

The proposed refinements focus on enhancing **clarity, strengthening progression coherence, and improving implementation guidance**. With these adjustments, the Framework is considered capable of meaningfully contributing to the systematic integration of data literacy within compulsory education in Poland.

Organization of the workshops

The national validation workshop in Poland was organized within the framework of the DATA-READY project (WP2 - Analysis and Identification of Best Practices). The purpose of the workshop was to present the rationale and structure of the proposed European Data Literacy Framework, to gather feedback from key stakeholders and teachers, to assess perceived feasibility of implementation within the Polish compulsory education system, and to identify potential barriers, challenges, and enabling conditions.

Participants received the Executive Summary Briefing five days before the workshop, together with access to the full framework document. During the meeting it became evident that most

participants had either not studied the materials in depth or had reviewed them only briefly. This circumstance influenced the structure and dynamics of the workshop.

A total of 42 participants attended the workshop:

- 17 stakeholders, including representatives of educational authorities, school leaders, academic experts, representatives of education-related institutions.
- 25 teachers, representing primary education, lower secondary education, various subject areas.

Due to time constraints on the part of both UKEN and participants, the stakeholder and teacher workshops were organized simultaneously in the same venue, with joint and separate group discussions.

Implementation of the Workshops

Presentation Part

The workshop began with a 30-minute plenary presentation covering the overall objectives of the DATA-READY project, the policy context (European and national), the conceptual foundations of data literacy, the distinction between data literacy and related concepts (digital literacy, ICT skills, statistics), the structure and domains of the proposed framework, and intended implementation logic. Given the limited prior familiarity with the materials, this introductory presentation became essential for establishing a shared conceptual baseline.

To clarify the meta-level nature of data literacy, an example was presented based on research conducted by Wojciech Stomczyński & Krzysztof Ciesielski (Jagiellonian University). Their work on electoral systems, including proposals related to seat allocation in the European Parliament, demonstrates that identical sets of votes may produce substantially different parliamentary seat distributions depending on the mathematical aggregation method applied. Their research on degressive proportionality and the so-called “Jagiellonian Compromise” illustrates how the design of decision rules influences collective outcomes. This example served to highlight the non-neutrality of aggregation methods, the importance of understanding decision structures, the role of mathematical modelling in democratic systems, and the broader civic and societal implications of data interpretation. The example contributed to a more precise understanding of the framework’s intention to develop competences related not only to handling data, but to critically engaging with data-based decision systems.

Discussion Part – Teachers

Teachers consistently referred to the perceived overload of the national curriculum. Concerns included:

- limited instructional time,
- administrative responsibilities,
- existing reform fatigue,
- the difficulty of integrating additional structured content.

A recurring argument was that introducing a new framework as an additional requirement would be difficult without structural adjustments.

After clarification that the framework is not intended as a new subject but rather as a transversal competence, discussion shifted toward:

- cross-curricular embedding,
- integration within existing subjects,

- project-based approaches.

However, teachers expressed the need for:

- concrete examples,
- ready-to-use lesson scenarios,
- clear alignment with existing curriculum objectives.

Dimension 1: Structural Clarity & Coherence

Q1. When you look at the framework, what feels clear and usable for you as a teacher, and what feels complex or difficult to navigate?

Q2. Do the domains, progression bands, and proficiency levels work together in a way that makes sense for classroom use, or are there points where the structure feels confusing?

Teachers initially experienced conceptual ambiguity regarding the structure of the framework. Many participants associate data literacy primarily with technical data handling or statistical operations and required clarification that the framework addresses broader interpretative and decision-related competences. After explanation, the overall architecture (domains, progression bands, proficiency levels) was perceived as logically organized at a theoretical level. However, teachers indicated that without concrete classroom examples, the structural coherence remains abstract. The relationship between domains and everyday teaching practice was not immediately evident. Greater visibility of links to existing curriculum components was considered necessary to enhance usability.

Dimension 2: Domain Completeness & Balance

Q3. Taken together, do the seven domains capture what data literacy should realistically mean for students in compulsory education?

Q4. Are any domains overlapping, missing, or too dominant compared to others from a teaching perspective?

Teachers generally did not question the completeness of the domains conceptually. Once clarified, the framework was perceived as covering a broad range of competences relevant to understanding and interpreting data in societal contexts. Nevertheless, concerns were raised regarding balance. Some domains were perceived as cognitively demanding and potentially too abstract for certain age groups. Teachers indicated that clearer differentiation between core transversal competences and more advanced subject-specific elements would support balanced implementation.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. Does the progression from Primary 1 to Lower Secondary reflect how your students actually develop data-related skills over time?

Q6. Do the proficiency levels (Starting–Intermediate–Advanced) help you understand expectations, or do they risk being confusing or unrealistic?

The progression logic was not discussed in technical depth due to time devoted to conceptual clarification. However, teachers expressed general concerns about feasibility of progression within an already saturated curriculum. Some participants noted that while early primary education (Grades 1–3) structurally offers flexibility, formalized progression in later grades might face systemic barriers. The need for clearer alignment with developmental stages and national curriculum transitions was implicitly suggested.

Dimension 4: Classroom Applicability

Q7. If you were asked to start using this framework next school year, where would you realistically begin?

Q8. What aspects of the framework feel most practically useful, and which feel hardest to apply in everyday teaching?

This dimension generated the strongest reactions. Teachers repeatedly referred to curriculum overload, limited instructional time, and administrative burden. The framework was perceived as potentially valuable but difficult to integrate if introduced as an additional requirement. Cross-curricular embedding was considered more realistic than establishing a new subject. Teachers emphasized the need for ready-to-use teaching scenarios, concrete examples, and visible alignment with existing subject requirements to enhance classroom applicability.

Dimension 5: Ethical Robustness & Equity

Q9. How confident would you feel using this framework to address issues such as privacy, bias, fairness, and responsible data use with your students?

Q10. Does the framework support inclusive practice for diverse learners, or are there areas where equity needs to be more explicit?

Ethical aspects became more visible during discussion of voting systems and decision rules. Teachers acknowledged that understanding how data aggregation affects outcomes has clear civic relevance. However, ethical dimensions were not discussed in systematic detail. No explicit objections were raised, but teachers did not elaborate extensively on inclusivity or differentiated access. The ethical dimension appears to be conceptually accepted but requires further operational clarification for classroom practice.

Dimension 6: Adoption & Sustainability Potential

Q11. What would make this framework something you actually use, rather than another policy document?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Teachers expressed skepticism regarding long-term adoption under current structural conditions. The dominant barrier identified was curriculum saturation. Sustainable adoption was perceived as possible only if the framework is positioned as an integrative transversal competence rather than an additional curricular layer. Systemic support, alignment with teacher training, and minimization of additional workload were implicitly identified as prerequisites for sustainability.

Discussion Part – Policymakers/Experts

Stakeholders' reactions differed from those of teachers. Several stakeholders indicated uncertainty regarding:

- the distinction between data literacy and digital competence,
- the positioning of the framework within national policy structures,
- the relationship between data literacy and existing competency-based reforms.

Questions were raised concerning:

- institutional responsibility for implementation,
- monitoring and evaluation mechanisms,
- alignment with teacher training systems,
- long-term sustainability.

Stakeholders generally focused more on structural and policy-level implications than on classroom practice. An interesting point of convergence between teachers and stakeholders concerned the early primary level.

Participants agreed that:

- structurally, Grades 1–3 offer greater flexibility,
- teaching at that level is less subject-fragmented,
- curriculum pressure is comparatively lower.

However, participants also expressed the view that formalizing data literacy competences at such an early age may raise developmental concerns, and further conceptual clarification would be necessary. This discussion revealed a tension between structural feasibility and perceived developmental appropriateness.

Dimension 1: Structural Clarity & Coherence

Q1. From a system or policy perspective, does the framework present a clear and coherent model of data literacy for compulsory education?

Q2. Is the internal logic between domains, progression bands, and proficiency levels appropriate for use as a reference framework?

Stakeholders demonstrated initial conceptual uncertainty regarding the distinction between data literacy and existing digital competence frameworks. Clarification was necessary to position the framework beyond ICT skills. Once explained, the structure was perceived as theoretically coherent. However, stakeholders emphasized the need for clearer policy-level articulation and definitional precision to avoid overlapping with existing competence frameworks.

Dimension 2: Domain Completeness & Balance

Q3. Do the seven domains together provide a complete and balanced picture of data literacy at system level?

Q4. Are any domains insufficiently developed, overly complex, or misaligned with current policy priorities?

Stakeholders did not question the conceptual comprehensiveness of the domains. The framework was seen as addressing relevant dimensions of contemporary data-driven societies. At the same time, questions emerged concerning prioritization and balance between analytical, interpretative, and civic components. Clearer communication of the framework's added value relative to existing curricular structures was considered important.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. How well does the progression logic align with curriculum design, learning outcomes, and assessment practices in your context?

Q6. Is the progression flexible enough to accommodate national and institutional variation?

Stakeholders did not engage in detailed analysis of progression bands but raised structural questions regarding alignment with national educational phases. Concerns were expressed regarding feasibility of systemic implementation across school transitions and teacher preparation systems. Greater clarity on governance and monitoring mechanisms was seen as necessary for structured progression.

Dimension 4: Classroom Applicability

Q7. In which concrete ways could this framework be used at system level (e.g. curriculum guidance, teacher PD, quality assurance)?

Q8. What implementation pathways seem realistic, and which seem problematic?

Stakeholders evaluated applicability primarily at system level rather than classroom level. Key concerns included institutional responsibility, integration pathways, and compatibility with national reforms. They recognized that implementation without clear institutional anchoring and teacher training alignment would be challenging. Applicability was thus perceived as dependent on systemic coordination rather than solely pedagogical design.

Dimension 5: Ethical Robustness & Equity

Q9. Does the framework sufficiently address ethical, legal, and societal issues related to data use in education?

Q10. Are there equity or rights-based considerations that should be more explicitly addressed at policy level?

The ethical dimension was acknowledged implicitly through discussion of voting systems and aggregation methods. Stakeholders recognized the civic relevance of understanding data-based decision processes. However, ethical and equity considerations were not extensively debated in operational terms.

Dimension 6: Adoption & Sustainability Potential

Q11. What conditions would be necessary for this framework to achieve long-term adoption rather than short-term endorsement?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Stakeholders emphasized governance and policy alignment as central to sustainability. Questions were raised regarding who would be responsible for implementation, monitoring, and teacher preparation. Sustainable adoption was considered possible only if embedded within existing competence-based reforms rather than introduced as a standalone initiative. Institutional anchoring and strategic communication were identified as key conditions.

Main outcomes - Teachers

The discussion with teachers revealed that the proposed Data Literacy Framework is perceived as conceptually relevant but structurally demanding within the current educational context. Initial reactions indicated a limited shared understanding of data literacy as a meta-level competence extending beyond technical data handling. Once clarified, the framework was recognized as theoretically coherent and addressing competences that are increasingly important in contemporary society. The dominant concern expressed by teachers related to curriculum overload and limited instructional time. The need for practical teaching examples, clear alignment with existing curriculum objectives, and visible connections to current practice was repeatedly highlighted. Teachers consider the framework meaningful in principle but difficult to implement without structural adjustments and practical support tools.

Main outcomes - Policymakers/Experts

Stakeholders approached the framework primarily from a systemic and policy-oriented perspective. Initial discussion revealed conceptual ambiguity, particularly regarding the distinction between data literacy and existing digital competence frameworks. Following clarification, the framework was perceived as structurally coherent and aligned with broader societal needs in a data-driven environment. Stakeholders focused less on classroom-level concerns and more on governance, institutional responsibility, and alignment with national education policies. Questions emerged regarding implementation pathways, monitoring mechanisms, and integration within existing competence-based reforms. The ethical and civic

relevance of data literacy was acknowledged, particularly through discussion of decision-making systems and aggregation rules. However, sustainability was seen as dependent on strategic policy positioning rather than purely pedagogical design. Stakeholders emphasize the need for clear institutional anchoring and alignment with systemic structures.

Reflection on the National Validation Workshops

Due to the limited prior familiarity with the framework, a substantial portion of the workshop was devoted to conceptual clarification, terminological alignment, and explanation of the framework's objectives. As a result, the workshop functioned partly as an awareness-building session, the amount of detailed validation feedback was limited, and concrete textual modification proposals were relatively scarce. Nevertheless, the discussion provided valuable insight into perception barriers, conceptual misunderstandings, implementation concerns, and communication needs.

The workshop revealed the following main points:

- Data literacy remains conceptually underdefined among practitioners and stakeholders.
- It is frequently conflated with ICT competence or statistics.
- Teachers perceive curriculum overload as a major barrier to implementation.
- Stakeholders require clearer policy positioning and alignment with existing frameworks.
- Cross-curricular embedding appears more acceptable than introducing a new subject.
- Awareness-raising is a necessary preliminary step before systemic implementation.

Based on the workshop discussion, the following implications may be considered:

- Development of a concise executive-level explanation of data literacy.
- Clear differentiation from digital competence frameworks.
- Preparation of classroom-level implementation scenarios.
- Alignment mapping with national curriculum structures.
- Communication strategies emphasizing civic and decision-literacy dimensions.

Evaluation of the Framework's Structure

The structure of the framework was perceived as theoretically coherent once its conceptual foundations were clarified. Both teachers and stakeholders recognized that the organization into domains, progression bands, and proficiency levels reflects a systematic attempt to operationalize data literacy across compulsory education. The framework's architecture was not fundamentally questioned in terms of internal logic. The workshop revealed that structural clarity depends strongly on prior conceptual understanding. Without explicit differentiation from digital competence or statistical literacy frameworks, participants initially experienced ambiguity. The structure appears internally consistent but requires clearer introductory positioning and definitional precision to ensure accessibility for practitioners and policymakers unfamiliar with the concept of data literacy as a transversal meta-competence.

Evaluation of the Framework's Content

The content of the framework was generally perceived as comprehensive and relevant to contemporary societal challenges. Participants acknowledged that competences related to interpretation, critical evaluation, and understanding of data-driven decision processes are increasingly important. The illustrative example concerning electoral systems helped make the civic dimension of the framework more visible and understandable. At the same time, the discussion suggested that some elements of the content may appear abstract or demanding without concrete context. Teachers indicated the need for clearer differentiation between foundational transversal competences and more advanced analytical components. Even if no



domain was explicitly rejected, participants implicitly called for clearer prioritization and practical exemplification to enhance comprehensibility.

Evaluation of the Framework's Applicability

Applicability emerged as the most critical dimension in the workshop discussion. Teachers expressed concern regarding integration within an already saturated curriculum, emphasizing time constraints and administrative workload. From their perspective, the framework's applicability depends on its positioning as an integrative cross-curricular competence rather than an additional curricular obligation. Stakeholders evaluated applicability at a systemic level, highlighting the importance of governance structures, policy alignment, and teacher preparation systems. Sustainable implementation was perceived as dependent on institutional anchoring and alignment with ongoing competence-based reforms. The workshop indicated that applicability is less a matter of conceptual validity and more a question of structural and systemic feasibility.

Recommendations for Revisions and Enhancements

Based on the discussion with teachers and stakeholders, the following recommendations for potential refinement of the framework may be considered. The workshop did not produce proposals for structural redesign of the framework. Rather, the recommendations focus on clarification, exemplification, and alignment. The core architecture was not fundamentally questioned. The primary challenges identified concern communication, positioning, and implementation pathways rather than conceptual validity.

1. Strengthen Conceptual Clarification and Positioning

Participants demonstrated initial ambiguity regarding the distinction between data literacy, digital competence, and statistical literacy. It is therefore recommended that the framework includes:

- A concise, clearly articulated definition of data literacy at the beginning of the document.
- Explicit differentiation from existing digital and ICT competence frameworks.
- A short conceptual overview explaining the framework's "meta-level" focus on interpretation, decision structures, and civic implications.

Improved conceptual positioning would enhance structural clarity and accessibility for practitioners and policymakers.

2. Increase Visibility of Practical Implementation Pathways

Teachers emphasized the need for clearer guidance on classroom integration. It is recommended that future revisions include:

- Illustrative teaching scenarios or short examples across different subjects.
- Explicit references to cross-curricular embedding strategies.
- Clear alignment notes showing where the framework connects to existing curriculum elements.

Such additions would support classroom applicability without altering the conceptual integrity of the framework.

3. Clarify Core vs. Advanced Competences

The domains were not challenged conceptually but participants suggested that some components may appear demanding or abstract. A clearer differentiation between:

- Foundational transversal competences (relevant across subjects).

- More advanced analytical or modelling competences (potentially subject-specific).

could enhance usability and perceived balance.

4. Provide Guidance on System-Level Implementation

Stakeholders highlighted the importance of governance and institutional anchoring. It is recommended that the framework includes:

- A brief section outlining possible implementation pathways at system level.
- Suggestions regarding integration within teacher training and professional development structures.
- Clarification of how progression logic aligns with national educational transitions.

This would strengthen sustainability potential and policy alignment.

5. Emphasize Civic and Societal Relevance

The example of voting systems and aggregation methods proved particularly effective in clarifying the framework's societal dimension. It is therefore recommended to:

- Explicitly highlight civic decision-making contexts as illustrative cases.
- Provide short explanatory examples demonstrating real-world relevance.
- Make the ethical and democratic implications of data literacy more visible within the document.

This may enhance stakeholder understanding and broader acceptance.

6. Avoid Perception as Additional Curriculum Burden

The strongest barrier identified by teachers was curriculum overload. It is therefore important that the framework:

- Clearly communicates its integrative and transversal nature.
- Avoid presentation as a standalone subject.
- Emphasizes embedding rather than expansion.

Revisions in framing and communication may reduce resistance and improve adoption potential.

National Report Portugal

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Executive Summary

This National Report presents the outcomes of the Portuguese validation workshops conducted within the DATA-READY project to assess the coherence, relevance, and implementation potential of the proposed Data Literacy Framework for compulsory education. Three workshops were organized: two with policymakers, experts, and institutional stakeholders, as well as a semi-structured interview, and one with in-service teachers from primary and lower secondary education. All the workshops took place online. Together, these workshops provided complementary system-level and classroom-level evidence to inform targeted refinement of the Framework.

Among Portuguese teachers and policymakers, there was a **consensus** that the Data Literacy Framework is a **conceptually sound and coherent reference**. Both groups recognize the relevance of the domain-based approach and its suitability for cross-cutting and interdisciplinary use, allowing data literacy to be framed as a comprehensive educational and civic competence. Policy makers particularly highlighted its methodological legitimacy, its potential to align with the curriculum, the need for training and quality assurance mechanisms, and its consistency with European digital and data competence frameworks.

At the same time, the discussions revealed a **clear distinction between the conceptual coherence of the framework and its practical usability in school implementation**. Teachers identified conceptual overlaps between related domains, such as Representation & Visualization, Analysis & Interpretation, and Communication & Decision Making, which reduce operational clarity in the classroom. They therefore suggested **clarifying domains** and proposed that Awareness, Ethics & Agency be repositioned as a cross-cutting dimension, accompanying all work with data, rather than being considered an isolated domain. Policy makers, in turn, reinforced the need to **separate** Communication & Decision, make the order explicit and clarify the concept of 'data' (data vs. information, veracity, AI, disinformation). Neither group valued a strictly linear reading of the structure; both favored networked logic, consistent with inquiry-based pedagogies and project-based learning.

The logic of progression and proficiency levels were identified as the area most in need of revision. Teachers argued that rigid age levels do not always reflect the reality of the classroom, which is marked by very heterogeneous development trajectories, inequalities in digital access and different levels of maturity. They argued that teaching cycles should function as flexible pedagogical zones, and that proficiency levels should be more detailed, observable and contextualized by domain, avoiding overly large conceptual leaps, especially between the Initial and Intermediate levels. Policy makers agreed with the general structure but emphasized the need for flexibility, continuity between cycles and explicit transition mechanisms.

Regarding applicability in a school context, both groups **reject the use of the framework in a holistic or prescriptive manner**. For teachers, the framework is more viable when worked on progressively, starting with domains such as Questioning & Problem Solving, exploration of everyday data, small tasks of interpreting graphs, and activities to combat misinformation. Successful implementation depends heavily on the availability of practical examples, lesson plans, activity models, accessible tools, and practical training. Throughout the discussions, it became clear that the main limiting factor is not the preparation of students, but rather that of the teachers themselves, reinforcing the need for continuous practical and collaborative training.

The ethical dimension was recognized as one of the strengths of the framework, particularly for its ability to link data literacy with critical thinking, autonomy, responsibility and digital citizenship. However, both teachers and policy makers highlighted the **need for more explicit integration of emerging topics**, including generative AI, authorship, transparency, different types of bias, privacy and equity. It was also noted that, although the framework mentions equity, this principle needs to be more operational, offering guidance on adapting to different student profiles, pedagogical differentiation and mitigating digital inequalities.

In summary, the validation workshops held in Portugal confirm the conceptual basis of the Data Literacy Framework, while identifying the need for revision in specific areas such as structural clarification, linguistic simplification, reorganization of boundaries between domains, reinforcement of cross-cutting ethics and improvement of the progression logic, to support its realistic, equitable and sustainable adoption in primary and secondary education. The combination of classroom evidence and educational policy evidence provides a solid basis for guiding the next version of the framework, balancing strategic ambition with pedagogical feasibility.

Organization of the workshops

Participants for the validation workshop for **policy experts and stakeholders** were recruited through professional networks, higher education institutions, and policy structures. Targeted invitations were extended to teacher educators, researchers in primary education pedagogy, and educational policy development.

The recruitment process yielded 8 stakeholders representing a range of educational, academic, and public administration institutions. Participants occupied roles associated with teaching and research in higher education.

Prior to the workshop, participants received a comprehensive preparatory package including (a) a concise summary of the Data Literacy Framework, its rationale, and theoretical grounding, (b) the discussion protocol outlining the six core validation dimensions, and (c) a pre-workshop validation survey designed to capture baseline perceptions and contextual information. This preparatory process ensured that participants engaged with the framework material prior to deliberations, facilitating more focused, informed, and productive discussions during the workshop itself.

Teachers from compulsory education schools in Portuguese schools were invited to participate in the workshop. This was a training course accredited by a school association training center.

Twenty-one teachers from various educational cycles, subject areas, and regions of Portugal participated. The workshop was held in an online format, following recommendations from the Teacher Training Centre to have participation from different regions of Portugal.

Several materials were prepared, including a presentation of the project, the main results of the Portuguese report, the main features of the draft Data Literacy Framework, and the role of stakeholders in the overall project implementation and validation process. Tasks to explore the Framework collaboratively were also prepared.

Implementation of the Workshops

The validation workshops for policy experts and stakeholders were conducted on 29 January, 6 and 10 February 2026, online. The workshops were designed to examine the proposed Data Literacy Framework across six core validation dimensions, eliciting expert perspectives on structural coherence, content completeness, progression logic, applicability, ethical considerations, and adoption potential.

The workshop followed a structured agenda comprising two main components: a short presentation segment and a moderated discussion segment.

The validation workshop for teachers was held as an online event on 23rd and 24th January 2026, comprising two hours of presentation plus four hours of structured discussion.

The schedule for both workshops included an opening session (welcome, icebreaker), presentation, discussion, and closing part:

- **Opening**
 - Welcome & objectives
 - Ice-breaking activity
- **Presentation**
 - WP2 preliminary research findings
 - National results from D2.1 DATA-READY report
 - Draft Data Literacy Framework (DLF)
- **Discussion**
 - Validation-oriented discussion
- **Closing**
 - Key takeaways
 - Next steps & feedback process...

Presentation Part

For the stakeholders, the workshop commenced with a presentation of the Data Ready project, aims and work in progress and the preliminary research findings from Work Package 2, including the main findings from D2.1 DATA READY report. Emphasis was placed on the Portuguese national results. Planned project deliverables were outlined, including the development of learning scenarios covering different domains and progression levels. Following this, the proposed Data Literacy Framework was presented, addressing its rational and theoretical basis, regarding domains, progression bands and proficiency levels. Participants were provided with visual representations of the framework structure.

For the teachers' validation workshop, the facilitators began by providing a brief overview of the DATA-READY project and highlighting key findings from the initial Data Literacy study, with particular emphasis on results from the Portuguese national context. A draft version of the Data Literacy Framework was then presented. Three tasks were designed to support participants in exploring the framework.

The tasks were carried out in groups using breakout rooms on the Zoom platform. In the first task, each group analyzed two domains of the framework and was asked to match the relevant competences to each domain. In the second and third tasks, participants examined the adequacy of the descriptors developed for each cycle of education and corresponding proficiency levels. After each task, groups presented their proposals, which were discussed in the plenary session.

Following completion of the tasks, the discussion protocol was clearly explained, including its objectives, procedures, and expected contributions, and this was followed by a structured discussion around the proposed questions. After the session, participants completed the main questionnaire as well as a workshop satisfaction survey.

Discussion Part - Teachers

This section presents the outcomes of the teacher validation workshop, with particular attention to the framework's clarity, internal consistency, and capacity for system-wide implementation in

compulsory education. Teachers' input is treated as accounts of classroom practice as well as practice-based evidence with implications for curriculum design, teacher professional learning, and policy enactment. The analysis explores the extent to which the framework's domains, progression bands, and proficiency levels form a coherent and flexible structure that can be integrated into existing national curricula, cross-curricular initiatives, and assessment approaches without generating unnecessary complexity or additional workload.

The following analysis is based on notes taken during the workshop that reflect participants' ideas and contributions, analysis of the tasks performed, and responses to the questionnaire.

Dimension 1: Structural Clarity & Coherence

Q1. When you look at the framework, what feels clear and usable for you as a teacher, and what feels complex or difficult to navigate?

Q2. Do the domains, progression bands, and proficiency levels work together in a way that makes sense for classroom use, or are there points where the structure feels confusing?

Data is presented on how teachers perceive the clarity, internal coherence, and navigability of the reference framework, while identifying aspects that facilitate its use and those that may limit its practical applicability.

Overall structure considered understandable

Most teachers consider that the framework has a logical structure, allowing them to understand its main areas. There is consensus regarding the document's good organization, which facilitates a first reading and overall interpretation. This perception is reinforced by teachers who say they see no need for changes, such as “*For now, I wouldn't change anything*” or “*Nothing*”.

Relationship between progression and teaching practice

Teachers report that the suggested progression, from simpler tasks to more complex activities, is consistent with how they plan and develop learning. This perception allows the framework to be seen as a potentially useful tool to support the planning of teaching activities.

Functional clarity of proficiency levels

The model presents three levels (Beginner, Intermediate, Advanced), and this organization is viewed positively by teachers who value the existence of differentiated indicators, as they consider that these guide expectations, facilitate the adaptation of tasks and help to structure formative assessment processes.

Technical language and terminological ambiguity

One of the most significant weaknesses relates to the terminology used. Many teachers mention that some terms, expressions or verbs are too technical, lack consensus between subjects or are ambiguous. The use of more than one action verb per competence/descriptor was also noted, which makes its operationalization and assessment difficult. Suggestions include requests such as “*Simplify it*”, “*Improve the vocabulary used to specify competences*”, or even a call for “*greater explicitness in the AE*”, which refers to both clarity and operationalization. The need for a glossary, simplification of language, conceptual clarity, and consistency in the formulation of descriptors is one of the most recurring recommendations.

Perceived requirements in the formulation of descriptors by cycle

Several teachers consider that some descriptors, especially in the 2nd cycle, are too demanding given the actual teaching and learning conditions. They associate this difficulty with the heterogeneity of classes, technological limitations, time constraints and contexts with very

different levels of digital literacy. Suggestions have been made to include intermediate stages or additional descriptors to make progression more gradual.

Structural coherence not always evident

Despite the generally positive perception, some teachers find it difficult to understand how domains, cycles and levels are linked at the operational level. The absence of practical examples, illustrative cases and applied guidelines is mentioned as a factor that hinders the coherent interpretation of the framework. This point is explicitly mentioned in comments suggesting that the reference framework should “*be more explicit in the AE*” or suggesting mechanisms to facilitate interdisciplinary interpretation, such as “*...creating an Interdisciplinary Translation Matrix, the biggest obstacle is that teachers do not know where the framework fits into their subject*”.

Overlap and delimitation of domains

Some responses identify possible overlaps between domains, particularly between Representation & Visualization, Communication & Decision-making and, to a lesser extent, Analysis & Interpretation. This suggests that the boundaries between domains could benefit from conceptual clarification. One explicit proposal was to “*Put permeable walls in the domain of Ethical Awareness and Agency with the other domains*” illustrating the need to make certain dimensions more cross-cutting.

Rethinking the place of the domain 'Ethics & Agency'

A significant number of teachers believe that this domain should be cross-cutting, functioning as a guiding principle for all the others, rather than as an isolated domain. This perception indicates that the current position of this domain raises conceptual doubts and may affect the overall coherence of the framework.

Contextual factors influencing the perception of clarity

Some teachers emphasize that the clarity and coherence of the framework also depend on institutional and material conditions, such as preparation time, specific training, access to equipment, Internet connection and availability of digital tools. These factors, although external to the framework, directly influence its actual usability.

Dimension 2: Domain Completeness & Balance

Q3. Taken together, do the seven domains capture what data literacy should realistically mean for students in compulsory education?

Q4. Are any domains overlapping, missing, or too dominant compared to others from a teaching perspective?

Analysis of teachers' responses to Dimension 2 Domain Completeness & Balance reveals an overall positive perception of the conceptual scope of the domains of the Data Literacy Reference Framework in compulsory education, although some comments are also made regarding the balance between them and the clarity of the conceptual boundaries that separate them. Consistently, participants consider that the domains presented realistically capture what data literacy should mean in the context of compulsory education. The articulation between technical, cognitive and ethical aspects is generally valued, with recognition that this combination allows for the construction of a comprehensive view of working with data, from questioning to decision-making. This integrated view is often referred to as appropriate to what a student is expected to develop throughout their school career.

Completeness of the seven domains

Most teachers demonstrate an understanding that the set of domains considers the different dimensions of data literacy. The diversity between technical, cognitive and ethical domains is seen as a positive aspect of the reference framework, adequately reflecting the complexity of working with data in the 21st century. For these teachers, the domains capture the essential dimensions of student training: questioning, formulating problems, collecting and organizing data, analyzing and interpreting information, communicating conclusions and making informed decisions. In this sense, the conceptual structure is referred to as complete and aligned with the contemporary demands of digital education, with some teachers stating that *“I think no further clarification is necessary”* or *“Nothing to consider”*.

Perception of discrepancies between domains

Although they consider that the domains fully describe data literacy, teachers also mention some aspects that may affect the navigability and practical coherence of the framework. One of the most prominent issues concerns the positioning of the domain Awareness, Ethics & Agency. Many teachers mention that this domain should not exist as an isolated category, but rather as a cross-cutting element that accompanies all the others. Along these lines, suggestions such as *“The domain of Ethics should be global and cross-cutting across all domains”* and *“In my opinion, the domain of ethics should not be isolated from the others, because, for me, it is inherent to the others”* arise. They consider that ethical reflection and the ability of students to make informed decisions are not skills that are developed separately, but that they should be present at all stages of the data work cycle, from collection to communication. Thus, the current structure, by isolating ethics, can be perceived as fragmented and less coherent from a pedagogical point of view.

Conceptual overlaps

Several teachers also point out possible overlaps between domains, which make their delimitation less clear. This difficulty is particularly evident between Representation & Visualization and Communication & Decision Making, and between Analysis & Interpretation and Communication. Some responses point out that the practical boundaries are not evident, such as when it is stated that *“Representation and analysis should be interrelated”* or when it is requested that descriptors and examples be made *“more explicit”* to avoid duplication. These overlaps raise questions about the practical separation of domains and may, in some cases, lead to redundancies in pedagogical planning.

Complexity and accessibility of the ‘Modelling & Automation’ domain

The Modelling & Automation domain appears to be the most challenging. Some teachers see this domain as distant from the most common teaching practices, especially in the early cycles or in less technical subject areas. They report difficulties associated with terminology, conceptual demands and a lack of support materials that make modelling more accessible. Practical examples are often requested from the definition of the domain, such as in *“For example, the domain ‘Modelling and Automation’ could be accompanied by practical examples, as these are not common terms in certain areas of teaching.”* In other cases, the difficulty is described as *“Confusing and very ambitious given the age level of the students.”* In certain school contexts, this domain is perceived as too advanced, creating an imbalance in the set of domains and requiring a review of its internal progression or the provision of graded examples that allow for a smoother transition between levels.

Recommendations

Although they do not consider that any domains are missing from the framework, teachers suggest several adjustments to improve balance and clarity, such as considering the Ethics & Agency domain as a cross-cutting dimension or clarifying boundaries between domains with strong interdependence, especially between visualization, communication and analysis. They

also suggest clarifying the modelling domain, making it more accessible, providing examples and practical guidelines to delimit the scope of each domain, or adjusting the complexity of the domains to the actual conditions in schools, considering limitations of time, resources, and training. In the words of the participants, it is important to “*improve the vocabulary in the specification of competences*”, promote “*awareness and training of teachers*” and “*their explicit integration into curriculum documents*”.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. Does the progression from Primary 1 to Lower Secondary reflect how your students actually develop data-related skills over time?

Q6. Do the proficiency levels (Starting–Intermediate–Advanced) help you understand expectations, or do they risk being confusing or unrealistic?

Overall positive perception of progression logic

Analysis of teachers' responses regarding the logic of progression from the 1st cycle to the 3rd cycle reveals an overall favorable perception of the proposed structure, although accompanied by concerns related to the appropriateness of the pace of progression, consistency between cycles, and the feasibility of learning in real classroom contexts. In general, teachers recognize that the idea of progression presented in the framework essentially corresponds to the natural development of data literacy skills that they observe in their students throughout compulsory schooling. Many mention that the transition from simpler to more complex tasks make sense in pedagogical terms and is in line with how students acquire data-related skills. This assessment can be seen in comments such as “*It is appropriate for the different cycles of education*” or “*The progression is demanding, as I think it should be, although this is not always reflected in reality*”.

Concerns about the level of difficulty

However, this positive perception is often accompanied by reservations related mainly to the level of difficulty assigned to certain cycles, particularly in the 2nd cycle. Some teachers indicate that, although theoretical progression makes sense, the reality of classes, marked by significant differences in maturity, autonomy, digital literacy and availability of resources, may make some descriptors too ambitious for certain school years. Comments such as “*In the second cycle, they don't have enough teaching hours... students don't have computers or the Internet to work with data*” and “*Some descriptors seem too ambitious given the actual conditions*” illustrate these concerns. In schools where there are constraints related to access to technology, limited access to computers, unstable Internet or lack of adequate tools, teachers report that certain levels of progression may be difficult to achieve. These structural limitations sometimes make the descriptors seem out of step with the actual pace of student development.

Need for greater specification between stages

Another recurring point in the responses concerns the need for intermediate stages within the progression logic itself. Several teachers suggest that, although the overall sequence is correct, it would be useful to introduce additional milestones to better manage transitions between levels, especially in classes where students move on to the next cycle without having fully consolidated their previous skills. This request is illustrated by comments such as “*Include intermediate stages for adaptation*” or “*It would be useful to introduce additional milestones to better manage transitions*”. This need is highlighted as particularly relevant for students who move between schools with different practices or when previous learning has been affected by a lack of curricular continuity.

Usefulness of proficiency levels for planning and assessment

Regarding proficiency levels (Beginner–Intermediate–Advanced), most teachers report that these help to clarify expectations, serving as a useful tool for both planning and formative assessment. Many value the existence of distinct levels, considering that these help to understand the type of performance expected and to tailor activities to the level of the students. Some comments reinforce this usefulness: “*The levels help to clarify expectations,*” “*They are useful for guiding activities and assessing.*” The levels are thus perceived as a positive contribution to understanding the goals of each stage, especially in contexts where there is great diversity in learning rates.

Difficulties in interpreting and implementing the levels

Despite this, some responses reveal concern that the levels may, in certain cases, be unclear or overly ambitious. Teachers who teach in the lower cycles, or in schools with more heterogeneous socioeconomic profiles, point out that the gap between the Initial and Intermediate levels may be too wide in some descriptors, creating the feeling that advancing from one level to another requires significant conceptual leaps. This is reflected in comments such as “*Confusing and too ambitious given the age level*” or “*Difficult to distinguish where one level ends and another begins*”. Others point out that certain terms or formulations make it difficult to clearly distinguish where one level ends and the next begins, which compromises the practical usefulness of the descriptors. There are also those who mention that some levels seem “*too advanced*” for the cycle in which they are included, fueling the perception of a lack of realism in the design of expectations.

Impact of the material and technological conditions of schools

There are also persistent practical difficulties arising from the material conditions of schools, which directly influence the possibility of completing some stages of progression as described in the table. These asymmetries in resources (human, technological, digital) amplify inequalities and make formal progression more difficult to achieve in a homogeneous manner. Teachers refer, for example, to “*Resistance from teachers, lack of training, scarcity of tools and time*” and “*Lack of time and lack of technological resources*”, directly linking these limitations to the successful implementation of progression.

Dimension 4: Classroom Applicability

Q7. If you were asked to start using this framework next school year, where would you realistically begin?

Q8. What aspects of the framework feel most practically useful, and which feel hardest to apply in everyday teaching?

Overall positive perception of the framework's applicability

Analysis of teachers' responses regarding the applicability of the framework in the classroom reveals a balanced view: on the one hand, teachers recognize its pedagogical potential and identify specific areas where they would begin to work; on the other hand, they highlight significant practical challenges, particularly related to actual working conditions in schools, which may limit immediate and full implementation. In general, most teachers say they would be able to start using the framework as early as the next school year, although they would tend to start with areas that are more familiar or easier to apply in their subject contexts. This perception is evident in responses such as “*Yes, definitely*” and “*With adequate support, I will be able to integrate it into my teaching*”.

Where teachers plan to start

When asked where they would start, many teachers say they would begin with areas that are already implicitly part of their teaching practices. The intention to start with Questioning &

Problematization, understood as the most cross-cutting and accessible domain, as it allows critical skills to be developed even in contexts with few resources, comes up very frequently. This is confirmed in responses such as 'Questioning & Problematization' or 'Awareness, Ethics & Agency', the latter mentioned by teachers who already address digital citizenship issues. Other teachers refer to areas related to Data Analysis and Interpretation or Data Acquisition and Management, where they already work with content such as statistics, graph interpretation or small investigations in class projects. Examples of this can be seen in statements such as “*Data analysis and interpretation*” or “*Data acquisition and management*”. There are also teachers who say they would start with simple activities related to combating misinformation, critical use of data in news or small information surveys in the context of the subject, “*Analysis of news and publications... to combat misinformation*”. In all cases, there is a tendency to start with areas that require fewer tools, less technical specificity, and greater proximity to existing practices.

Aspects of the framework perceived as most useful in practice

Several teachers point out aspects of the framework's practical usefulness that are considered particularly valuable for their daily work. Of note are the clarity of the domains associated with critical questioning, the interpretation of information, the analysis of real data close to the students' everyday lives, and the possibility of promoting active learning with social relevance. Examples provided include “*Data storytelling on global issues such as climate change*” and “*Activities to combat misinformation*”, which show how teachers anticipate using the framework to reinforce critical literacy and intellectual autonomy. For many, these elements represent consistent pedagogical opportunities. Some teachers also mention that the existence of a structured progression supports planning, especially in mathematics or interdisciplinary activities.

Aspects of implementation perceived as most difficult

Despite the positive aspects, the responses also highlight challenges that hinder the full application of the framework daily. Obstacles include a lack of time in the curriculum to integrate new activities, a shortage of technological resources, problems with internet connection, and a lack of specific training, especially in areas such as Modelling & Automation. This is clear in comments such as “*In the 2nd cycle... students do not have access to computers/the internet*”, “*Lack of time to integrate it into the curriculum*”, “*Resistance from teachers, lack of training, scarcity of tools and time.*” Many teachers mention that these constraints can prevent consistent and equitable application of the framework across classes, schools or cycles, creating asymmetries in how students access data literacy experiences.

Need for examples, scripts and support materials

Another aspect that is often mentioned is the need for concrete examples, lesson plans, activity models and good practices that help to operationalize the domains in a clear and realistic way. For many teachers, the practical usefulness of the framework depends heavily on the existence of such materials. This is explicitly stated in responses such as “*Training for teachers, tools (physical and digital) and a practical support manual*”, “*Concrete examples of application, training and tools would be useful*”, “*Precise indication of what will be covered*”. Without these resources, there is a risk that the framework will remain too conceptual and distant from routine classroom practices. Teachers in the early years also emphasized the need to adapt examples and descriptors to the cognitive maturity of younger pupils to ensure implementation appropriate to their abilities.

Dimension 5: Ethical Robustness & Equity

Q9. How confident would you feel using this framework to address issues such as privacy, bias, fairness, and responsible data use with your students?

Q10. Does the framework support inclusive practice for diverse learners, or are there areas where equity needs to be more explicit?

Analysis of teachers' responses regarding the dimension of ethical robustness and equity reveals an overall positive perception of the framework's potential for addressing ethical issues with students, while also pointing to several needs for clarification, reinforcement, and operationalization. Teachers recognize the importance of integrating topics such as privacy, bias, fairness, and responsible data use into teaching practice, but express doubts about the extent to which the framework, as formulated, is sufficiently explicit, accessible, or applicable in diverse contexts. Several responses raise concerns such as *"I think the main issue is student privacy and data protection. Therefore, clear guidelines on the use of this data should be provided"* and *"Equity in Access and Ethics of Creation vs. Data Plagiarism"*.

Moderate confidence of teachers in addressing ethical issues

In general, many teachers say they feel moderately confident in using the framework as a starting point for addressing ethical issues with students. For those who already work with critical analysis of information, interpretation of graphs, misinformation, or data-based decision-making, the framework is seen as an opportunity to deepen ethical debates and promote critical thinking among students. At the same time, some point out that they depend on greater practical support, as can be seen in *"More training for teachers in this area and more opportunity for flexibility in teaching"* and *"Awareness-raising and training for teachers"*. In their responses, some teachers say they feel comfortable addressing privacy, security and decision-making, while others express concern about working on topics such as bias or the social impacts of data, as they feel the framework lacks concrete guidelines. Some explicitly state that they would only feel confident with prior training or structured materials. Several teachers emphasize that confidence will depend heavily on the conceptual clarity of the descriptors, the specificity of the examples provided, and the availability of practical training that allows them to fully understand the ethical aspects associated with each domain.

Potential of the framework to promote inclusive practices

Regarding equity, many teachers recognize that the framework has the potential to support inclusive practices, as it explicitly refers to the importance of responsibility, fairness and impartiality in the use of data. Teachers working with diverse classes indicate that discussing data can open space for reflection on inequalities, representation and opportunities, making students more aware of the links between data and social justice. This understanding is expressed in statements such as *"From an equity perspective, it is essential to ensure that all students have access to the same opportunities, resources and digital tools, preventing socio-economic or digital literacy differences from conditioning participation and success."* However, analysis of the responses reveals that this potential is not fully developed in the way the framework is written. Many teachers indicate that the principles of equity are not sufficiently detailed, which makes it difficult to translate them into concrete practices, especially in contexts of greater educational need. Others mention that equity is treated in a generic way and should be explained more clearly in the descriptors, particularly to support teachers with less experience in ethical or social justice issues.

Areas where equity needs greater emphasis or clarity

Teachers make suggestions about where and how equity should be made more explicit. Some mention that it is essential to clearly address how data can reflect social, territorial or technological access inequalities to ensure representativeness and avoid data bias. It is also emphasized that students have very different levels of digital skills and access to technology, which should be explicitly considered in the framework. Some responses call for *"precise*

indication of what will be addressed” and “its explicit integration into curriculum documents” as a way of guiding adaptations to different contexts. Some participants mention that the framework does not provide sufficient guidance for adapting data literacy practices to students with different learning rhythms, and it is also proposed that equity be addressed across all domains, as suggested in relation to the domain of ethics.

Difficulties identified in ethical and inclusive application

Although some teachers feel confident about working on ethical issues, the responses reveal several structural difficulties. Aspects such as the use of complex terminology, especially in topics such as bias, algorithmic justice or automation; the lack of concrete examples, which makes it difficult to apply ethical concepts in real activities; and time/training/resource constraints are mentioned. These barriers appear in statements such as “*Lack of time for integration into the curriculum and insufficient training and support for teachers*”, “*Resistance from teachers, lack of training, shortage of tools and time*” and “*No space in the curriculum*”. Some areas are considered too complex, which makes it difficult to discuss the associated ethics. Other aspects focus on inequality among students, which makes teaching data ethics more demanding, especially when students have very different levels of digital literacy. These difficulties reinforce the idea that the ethical robustness of the framework depends not only on its conceptual formulation, but also on the actual conditions in schools and the support materials that will be made available.

Dimension 6: Adoption & Sustainability Potential

Q11. What would make this framework something you actually use, rather than another policy document?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Analysis of teachers' responses on the adoption and sustainability of the framework reveals a clear tension between recognition of the potential value of the framework and the perception of significant obstacles to its continued use in schools. Although many teachers say that the framework can positively influence teaching practice, they also identify structural and cultural conditions that may compromise its full adoption and continuity over time.

Conditions necessary to ensure the actual use of the reference framework

Teachers consistently emphasize that the framework would only become a truly used document, and not just another educational policy, if concrete support structures were made available, namely practical and continuous training, time for collaborative planning, access to technological tools and resources, and clear integration into school documents and practices. Otherwise, the framework may remain peripheral and optional, quickly overtaken by other institutional priorities. The reference framework will be considered more functional if it includes concrete, ready-to-use examples, adapted by cycle and domain; tools that reduce workload; interdisciplinary material that helps to understand how the framework fits into different subject areas; it is also important to provide for formal recognition of teachers' efforts, with incentives or professional recognition associated with implementation and curricular flexibility, allowing the framework to be integrated without conflicting with compulsory content. These suggestions show that adoption depends as much on the quality of the framework as on the quality of the context in which it is used.

Obstacles and barriers to the sustainability of the framework in schools

Obstacles and barriers to the sustainability of the framework in schools are also mentioned, namely lack of time and teaching workload, resistance to change and conservative school

culture, lack of adequate technological resources, lack of stability in teaching staff, difficulties in interdisciplinary coordination and lack of internal leadership.

Closing question

If you could change one thing in the framework to make it more useful for teachers, what would it be?

The aspects that teachers would change in the framework to make it more useful are in line with what was mentioned in the previous questions, explicitly stating 'I have already mentioned the aspects I would change'. When they explain, they refer to the **need for an explicit curricular link**, namely a clear link to Essential Learning and a disciplinary articulation matrix. Teachers say that without this link, it is difficult to understand 'where the reference framework fits' into each subject, as one participant expressed when suggesting the creation of an 'Interdisciplinary Translation Matrix, the biggest obstacle is that teachers do not know where the framework fits into their subject' or by asking for the framework to be 'more explicit in the Essential Learning'. To respond to this need, they recommend developing an Essential Learning–Domains matrix by subject and school year, accompanied by model plans and concrete examples of curricular integration.'

Another recurring theme is the **simplification and clarification of language**, especially in terms of descriptors. Some teachers openly ask for it to be "simplified", while others stress the importance of making certain elements more explicit. This suggests that the framework would benefit from shorter descriptors, with a **single operative verb, a common glossary and practical examples** to help interpret the scope and level of complexity of each competence. The creation of notes distinguishing between levels (Beginner, Intermediate and Advanced) with observable indicators would also help to reduce ambiguities and facilitate implementation.

Concerns were also raised about the **internal organization of the domains**, particularly regarding the positioning of the domain 'Ethical Awareness and Agency'. One suggestion was to "place permeable walls in the domain 'Ethical Awareness and Agency' with the other domains," highlighting the perception that ethics should be cross-cutting and not isolated. Therefore, a conceptual reorganization is recommended that integrates ethical checkpoints in all domains, accompanied by guidelines on bias, privacy and data justice, in order to support teachers in addressing these issues in a real-world context.

A significant number of responses indicate a lack of proposals for change, with statements such as 'Nothing' or 'For now, I would not change anything'.

In general, the themes and statements in Q13 converged: teachers value the structure of the framework but consider it essential to make it clearer, more applicable, and better supported. The recommended actions (curriculum matrix, linguistic simplification, mainstreaming of ethics, and practical support materials) point to the way to transforming the framework into an operational tool that is coherent and effectively useful in everyday teaching.

Discussion Part – Policymakers/Experts

Dimension 1: Structural Clarity & Coherence

Q1. From a system or policy perspective, does the framework present a clear and coherent model of data literacy for compulsory education?

Q2. Is the internal logic between domains, progression bands, and proficiency levels appropriate for use as a reference framework?

Value of the reference framework: recognized basic coherence

There is recognition that the document fulfils its function as a framework: it identifies domains and competences by education cycle and indicates a measurement of levels, in line with other literacies. This perception underpins the basic coherence necessary for discussion and policy alignment. As one participant summarized, *“what is presented here fulfils the purposes required of a reference framework”* and *“seems to me to be very much in line with what is done in other literacies”*, suggesting that the overall architecture inspires confidence and institutional comparability. However, attention is drawn to the need to analyze the relationship of this reference framework with others, for example DigCompEdu (2017), DigComp 3.0 (2025), European Digital Competence Framework, by Cosgrove and Cachia (2025), Data and Information Literacy, in which data literacy appears as the first dimension.

Number and scope of domains: excess, overlap and repetition

Despite the basic coherence, several interventions point to too many domains, overlaps and repetitions, which ultimately reduce clarity and ease of navigation. The recurring recommendation is to aggregate and better organize the set to preserve conceptual coverage with less cognitive load. As was said: *“perhaps so many domains are not necessary. Some domains could be more interconnected. There are repetitions.”* This perception points to simplifying without losing substance, to also support large-scale adoption. *“It will also be important to analyze the relationship between the Reference Framework and others, for example, the European Framework for the Digital Competence of Educators: DigCompEdu (2017), DigComp 3.0 (2025), the European Digital Competence Framework by Cosgrove and Cachia (2025), Data and Information Literacy, information and data literacy is part of the framework, also appearing in others. It is usually the first dimension to appear. So my first question is, I think it is important to understand what this component is, how it fits into the other components of this framework, because, for example, if I see communication or decision-making here, there are some frameworks that consider these skills on their own and not linked to literacy, I call it data literacy, and not just linked to data literacy. On the other hand, it was also mentioned that some domains are new, a surprise, ‘there is also something new here in terms of awareness, ethics, agency, for me, it is somewhat new. There is also the issue of modelling and automation. I think there is something new here in terms of the reference framework for data literacy (...) it is interesting to start working on the issue of modelling right from the first cycle. Interesting, it seems interesting, we weren’t expecting to see that. (...) Normally, students don’t work much with spreadsheets, they fail, perhaps it is the teacher who does this work and then the students can interpret the results. Here, this care is already beginning to be taken, which is what seems to me to be a change in this work”.*

Order of domains: start by questioning, analyzing, then representing

Participants advocate starting with questioning/problematization, moving on to analysis/processing and only then representation/visualization, in line with the natural cycle of investigation and decision-making. Several statements converge: *“the framework should also start with problematization and questioning”* and *“data analysis/processing should come before representation/visualization”*. This reordering helps to clarify relationships between domains and to establish a more intuitive progression logic for teachers and students.

Separating 'Communication' from 'Decision-making'

There is a strong consensus that 'Communication' and 'Decision-making' should not be together in the same domain. In practice, participants see 'Decision-making' as a stage that follows critical evaluation/analysis and, at the same time, cuts across the process. The interventions are clear: *“communication and decision-making seem to me to be two parts that do not make much sense to be together”* and *“I would not put communication together with decision-making”*. In terms of

reference, separating these elements improves readability, clarifies what is learned and how it is assessed at each point along the way.

Representation of the model: from circle to visible sequence

The current circular visualization is perceived as uninformative in terms of starting points and progression, which has an impact on overall clarity and internal logic. Hence the proposal for a linear representation or, while maintaining circularity, to include numbering and arrows to make the flow explicit. The criticism was direct: *“it would be better to represent it linearly than circularly... or else put numbers on it. We don't know where it starts.”*. For adoption in policies, the visual form must communicate, without ambiguity, the articulation and order of the components. The skills considered crosscutting could be represented in such a way as to encompass the other skills, for example, like a crown, *“So, ethics around it, right? In satellite (...) this graphic representation can also be deconstructed and another constructed. In other words, if we assume linearity, which is also debatable, we can find another way to represent these domains and the relationship between them”*.

Definitions and scope of 'data': clarify, including AI and veracity

The conceptual clarity of the Framework is considered insufficient in terms of what is considered 'data' (quantitative, qualitative, images, online text, etc.) and how veracity and authenticity are assessed, especially in a scenario with AI and fabricated content. The request is explicit: *“what is data? ... distinguish what is AI and what is not. What is true data? What is fabricated data?”* and *‘data is information... it is important to train... how students look at data and trust it.’*. This clarification is a requirement for a robust and up-to-date reference framework, avoiding narrow or biased interpretations.

From 'Acquisition and management' to 'Access to data': aligning with actual practice

In the school context, access to existing repositories and sources (rather than primary collection) predominates. Therefore, it was proposed to rename the domain to 'Access to data', with a focus also on licenses, legitimacy of access/sharing, storage and security. As formulated: *“I would change it to 'data access'. Because everything is access... not everything is collection”* and *“it is ethics in access... legitimacy in access... and in what will be shared.”*. This change would improve internal logic and curricular relevance, making level-based assessment more consistent with the reality of schools.

Progression by cycles and proficiency levels

Progression is seen as conceptually sound, but needs adjustments: some goals are *“too ambitious for the 3rd cycle of basic education”* and should be moved to secondary education; there is technical terminology (e.g., "sampling") that makes it difficult for generalist teachers to understand; and the descriptors have a quantitative bias, with a suggestion to open them up to the qualitative (*“refine questions to make them operational, not just measurable”*). These adjustments are essential for the progression and levels to be usable as a guiding reference in policies and practices.

Ethics and Decision-making as cross-cutting themes

The participants considered that Ethics and Decision-making should be explicit and operational throughout the entire process (before, during and after). Their statements are illuminating: *“this issue of ethics... affects all other domains... upstream and downstream and throughout the entire process”* and *“decision-making involves heuristics, biases and cognitive and affective factors.”* At the system/policy level, this cross-cutting approach reinforces coherence and internal logic, avoids “islands” and brings the reference framework closer to real decisions in an educational context. *“(..) I don't know if you also had this perception, but in almost all domains a question*

arises, even in the questioning, there is always a question more related to ethical aspects. There are always items, in the identification of the various competences within the domains, that are more related to ethics”.

Dimension 2: Domain Completeness & Balance

Q3. Do the seven domains together provide a complete and balanced picture of data literacy at system level?

Q4. Are any domains insufficiently developed, overly complex, or misaligned with current policy priorities?

Overall completeness with a need for ‘tidying up’

In general, experts/participants recognize that the seven domains cover data literacy at the system level but consider that the current structure could be more economical and less redundant. The prevailing perception is that there is overlap and repetition between areas, which makes reading and implementation difficult: *“Perhaps so many domains are not necessary. Some domains could be more interconnected. There is repetition.”*. In terms of systemic balance, the proposal is to consolidate/aggregate related domains, preserving coverage but reducing the cognitive load for teachers and decision-makers.

Sequence

For completeness to translate into balance, several participants advocate making the sequence explicit. As stated, the framework should also begin with ‘problematization and questioning’ and ‘data analysis/processing should come before representation/modelling’ (C). This sequence brings the framework closer to the actual data work cycle in schools, reduces ambiguities and improves the internal logic between domains.

Separating “Communication” from “Decision-making”

One structural weakness already mentioned is the combination of “Communication” and “Decision-making”. The group recommends separating these domains because decisions should come after critical evaluation/analysis and involve cognitive and affective processes; communication, on the other hand, focuses on translating results, adapting to audiences and being honest about uncertainties. The need to include the retranslation of results for communication is emphasized here. *“Communication and decision-making seem to me to be two parts that do not make much sense to be together.”*. (C); *“I would not put communication together with decision-making.”*. (AP). The separation clears up overlaps, rebalances the whole and makes the proficiency criteria clearer for each area.

From “Acquisition and management” to “Access to data”

The domain “Acquisition and management” appears to be less aligned with the school’s usual practice, where access to existing data predominates over primary collection. Therefore, it is recommended to rename and refocus the domain to “Data access”, incorporating licenses, legitimacy of access/sharing, organization, storage and security: *“I would change it to ‘data access’. Because everything is access... not everything is collection.”*; *“It’s ethics in access... legitimacy in data access and what will be shared.”* This refinement reduces complexity, aligns with policy priorities and reinforces the functional distinction between domains. *“I consider these that I am seeing to be relevant. The issue of ethics, awareness and then communication and even dissemination, which is important sometimes to learn how to disseminate data and then use it to make decisions, I think that is essential. Of course, we are already used to the other domains, aren’t we? So, data acquisition and management, presentation and visualization, I think that’s what we work on most in the domains, isn’t it? There are some here that are important, aren’t there? In this context, nowadays and increasingly important, it makes perfect sense for*

them to be included in this reference framework. Not least because I recently read a report on expansion, educational assessment and some of the issues relating, for example, to experimental teaching, which had to do with interpretation, data representation and problematization, and these are issues that students find quite difficult, so it is entirely relevant to work on and implement this reference framework, and I think these domains are essential, in my view”.

Ethics as a horizontal priority

To maintain balance and update the reference framework to current priorities, the group calls for cross-cutting ethics. ‘This issue of ethics... affects all other domains... upstream and downstream and throughout the process.’ (L). Clarifying what counts as ‘data’ (quantitative, qualitative, image, online text), and how to distinguish between real and fabricated data, is also crucial: *“It is important to distinguish between what is AI and what is not; what is real data and what is fabricated data.”* ‘Data is information... it is important to train... how students look at data and trust it.”.

Complexity, language and appropriateness by cycle

There are domains/descriptors that become complex due to technical language (sampling, etc.) and a quantitative predominance that can alienate generalist teachers. Participants propose simplifying terminology and balancing quantitative and qualitative aspects, for example, *“refining questions to make them operational, not just measurable.”*. They also point to inappropriate levels of ambition in the 3rd cycle: ‘Some skills are too ambitious for the 3rd cycle, perhaps more appropriate for secondary school. *“In secondary school, I think it’s feasible. My question here has a lot to do with the third cycle and even the first cycle. Models, well, it’s a process that takes time, isn’t it? For example, they have, of course, the level of proficiency, which I will also talk about later, which is a lower level and can be applied at the first cycle level. Of course, this domain would have to be spiral-shaped. It’s like all subjects; teaching is all spiral-shaped. And of course, it could be introduced at a lower proficiency level in primary school”*’.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. How well does the progression logic align with curriculum design, learning outcomes, and assessment practices in your context?

Q6. Is the progression flexible enough to accommodate national and institutional variation?

Conceptual adequacy of progression to the curriculum – coherent but needs structural adjustments

The experts recognize that the progression logic is conceptually sound and compatible with competence-based curricula, but it is not fully adjusted to the actual pace of student development and teaching practices in Portugal. One concern is that several descriptors, particularly in the field of Modelling and Automation, are too advanced for the 3rd cycle, being closer to the profile expected for secondary education: *“Some skills are very ambitious for the 3rd cycle, perhaps more appropriate for secondary education.”*. This perception suggests that, although the framework has a coherent progression in theory, it needs to be calibrated per cycle to ensure that proficiency levels correspond to students’ cognitive development and the actual curriculum. Another aspect mentioned relates to the need to better explain the progression between stages, so that reading the path (from start to finish) is more intuitive for teachers. The current circular representation raises questions about continuity: *“It would be better to represent it in a linear rather than circular way... we don’t know where it starts.”*. Clarifying the order of progression would facilitate integration with learning outcomes and curriculum planning.

Progression descriptors and language are technical, with a predominantly quantitative approach

Several participants point out that some descriptors are formulated using language typical of academic research, particularly in the field of data analysis. Terms such as sampling are not easily interpreted by early cycle teachers: “There are overly technical terms such as sampling that may not be understood by everyone.”. In addition, the table seems to suggest a markedly quantitative approach, which may lead to distorted interpretations of the type of literacy intended. In this regard, it is recommended that the wording be adjusted: “*Refine questions to make them operational, not just measurable.*” This criticism indicates that progression needs to better incorporate qualitative data.

Need for explicit and coherent progression between domains – direct impact on the logic of progression

The balance of progression depends heavily on the logical order of the domains, which is currently unclear or non-sequential. Participants argue that the structure of the framework should reflect the actual sequence of learning, so that the organization by levels makes sense. Therefore, they suggest starting with questioning, moving on to analysis/processing, and only then working on representation/modelling. “*The framework should also start with problematization and questioning.*”. “*Data analysis/processing should come before representation/modelling.*”. As progression is based on the logic between domains, any structural change interferes with the clarity of proficiency levels. Thus, progression would be more coherent if the framework explicitly assumed this flow, allowing advancement between levels to follow the evolution of the natural cycle of learning with data.

Insufficient flexibility in its current form – need for national and institutional adaptation

When asked about flexibility, participants point out that the structure could be more adaptable to the different contexts and realities of schools. Although they recognize that the conceptual structure allows for variation, the concrete formulation of the descriptors and the ambition at certain levels do not reflect the existing diversity. A truly flexible progression should incorporate alternative descriptors, differentiated strategies by cycle, accessible language, and explicit suggestions for local adaptation, something still missing from the current document.

Decision-making and ethics as cross-cutting competences – implications for progression

The participants argue that Decision-making and Ethics should be transversal domains that accompany all cycles of progression, not just final or static levels. This requires that progression systematically includes critical evaluation skills and recognition of heuristics/biases, as these evolve with the student's maturity: “*Decision-making involves heuristics, biases, and cognitive and affective factors.*”. “*Ethics should affect all other domains... upstream and downstream and throughout the process.*”. The absence of this explicit transversality sometimes makes progression seem segmented, hindering institutional adaptation and reducing applicability in more integrated curricula.

Dimension 4: Classroom Applicability

Q7. In which concrete ways could this framework be used at system level (e.g. curriculum guidance, teacher PD, quality assurance)?

Q8. What implementation pathways seem realistic, and which seem problematic?

Potential uses at system level

Participants recognize that the framework has the potential to function as a guiding tool for public policy, particularly in supporting curriculum alignment, defining key competences by cycle, and clarifying the role of data in different areas of knowledge. Several interventions reinforce that the framework fulfils well the function of a reference point that identifies domains and competences

throughout schooling: “What is presented here fulfils the purposes required of a reference framework...”

Applicability limited by lack of examples and distance from actual practice

Despite its usefulness as a reference, participants express concern about the lack of concrete examples, application scenarios, and practical translation. Some domains and descriptors appear too abstract or designed by researchers: “*I think this was done by researchers... the sampling may not be understood by everyone.*”. This distance between the conceptual framework and everyday school life raises the risk of low adherence in application. It is hoped that the document will be supplemented by examples of use, learning situations, student tasks and pedagogical strategies, to facilitate its transposition into practice.

Teacher training as an indispensable condition for any implementation pathway

Teacher training is identified as the most critical factor for classroom application. Training should cover both conceptual aspects (data, ethics, veracity, AI) and practical aspects (tasks, methodologies, digital tools, disciplinary integration). Thus, the framework could be used by the system to guide professional development programs, from initial to continuing training. “*Of course, gradually, considering the pedagogical and didactic aspects, but it is essential to start from the early years of schooling. And we have noticed difficulties with interpretation and representation, especially in the training of educators and teachers. In our case, in the experimental sciences, we encounter this a lot.*”

Cross-curricular implementation is desirable but difficult

Most participants recognize that data literacy is cross-cutting but warn of the difficulties of interdisciplinary implementation in the Portuguese context, where collaboration between disciplines is uncommon.

Specific barriers

Some areas of the framework are seen as difficult to apply due to the language and nature of the skills. There are technical descriptors, especially in the field of data analysis and collection/management, that are not suitable for all levels of education: “*There are overly technical terms such as sampling that may not be understood by everyone.*”. Furthermore, the perception that the framework is too focused on quantitative approaches (“*it is too biased towards quantitative data and the survey method*”) reveals that, without reformulation, it risks being applied in a limited way to certain STEM areas, when it should involve all subjects.

Dimension 5: Ethical Robustness & Equity

Q9. Does the framework sufficiently address ethical, legal, and societal issues related to data use in education?

Q10. Are there equity or rights-based considerations that should be more explicitly addressed at policy level?

Ethics is recognized as being present, but not sufficiently cross-cutting

Participants recognize that the framework incorporates an ethical dimension but consider that it should not function as an isolated domain. Instead, it should be integrated throughout the entire process, from questioning to communication and decision-making. One of the clearest contributions is: “*This issue of ethics... affects all other domains... upstream and downstream and throughout the entire process.*”. The general perception is that, although there is a domain dedicated to ethics, the current framework does not guarantee transversality, nor does it sufficiently highlight the ongoing role of ethical reflection in the educational use of data. To ensure

ethical robustness, greater explicitness in the descriptions would be necessary, including explicit connections to all other domains.

Need to clarify veracity, authenticity and risks of misinformation

A major concern is that the framework does not yet address sufficiently explicitly the challenges associated with data veracity, the production of fabricated data, the use of content generated by artificial intelligence, and the risks of misinformation in the school context. The group clearly verbalizes this need: *“It is important to distinguish between what is AI and what is not; what is true data and what is fabricated data. And I don't see that there.”*. This topic, which is now central to civic and digital education, is identified as a missing element that should be explicitly incorporated into the framework to ensure that data literacy encompasses validation and critical judgement skills.

Lack of clarification of what counts as ‘data’

The absence of a clear definition of what is meant by 'data' compromises the ethical and conceptual robustness of the framework. Participants note that different types of information (quantitative, qualitative, images, online texts, AI-generated data) require different ethical considerations. Hence the comment: *“What is this data? Is it quantitative data? Is it images? Is it any information from the internet?”*. The current lack of definition affects the consistency of ethical recommendations, as it does not distinguish between degrees of sensitivity or risks associated with different types of data.

Strengthening accountability and reporting

Experts argue that the framework should include descriptors related to accountability and reporting of inappropriate behavior, both in accessing and using data. *“In ethical aspects, provide a descriptor that refers to the need to report behavior.”*. This suggestion focuses on civic and integrity skills, which are essential for a framework geared towards compulsory education. It also reinforces the need for ethics of use and sharing, and clear mechanisms for action when ethical standards are violated.

Legitimacy of access and sharing - an insufficiently developed ethical component

Another ethical axis highlighted is that of legitimacy, consent, and governance of access. The discussion shows that these aspects are seen as central to data literacy but appear only implicitly in the framework: *“It is ethics in data access. Legitimacy in data access. And access that will be shared with others.”* This topic is directly linked to legal principles (data protection), digital security, school policies, and education for digital citizenship.

Structural inequalities and teacher capacity

The issue of equity arises in the group more in relation to the actual feasibility of implementation than to the conceptual content of the framework. Participants recognize that, although the framework has the potential to be applied across the system, there are profound inequalities between schools, particularly in terms of resources, teacher profiles, and prior training in digital and data literacy. This inequality is not explicitly stated in the framework but should be part of the policy recommendations.

Excessive technical language as a factor of professional inequality

Technical language, especially in the areas of data analysis and collection, limits the ability of many teachers to apply the framework equitably across classes and schools: *“There are overly technical terms such as sampling that may not be understood by everyone.”*. This creates pedagogical inequality: teachers with more training can operate complex descriptors; others are

not. For equity policies, it would be necessary to simplify the language and offer practical examples that ensure equal access to the reference framework.

Lack of contextualization of requirements by cycle

Related to language, progression by cycle presents levels that may exceed the actual abilities of many students (especially in the 3rd cycle), which affects curricular equity: “Some skills are too ambitious for the 3rd cycle, perhaps more appropriate for secondary school.” This means that if the framework were applied uniformly, students from disadvantaged backgrounds could be more penalized, a clearly relevant issue for equity and educational rights policies.

Dimension 6: Adoption & Sustainability Potential

Q11. What conditions would be necessary for this framework to achieve long-term adoption rather than short-term endorsement?

Q12. What risks or barriers could prevent sustained use of the framework in schools?

A necessary improvement for the framework to function as a truly credible policy instrument is the clarification and reorganization of its conceptual architecture. As already mentioned, separating 'Communication' from 'Decision-making', making ethics cross-cutting, making the progression between domains explicit and extending 'data' to 'data and information', including veracity, AI and access, accompanied by the promotion of teacher training that enables these domains to be interpreted and applied with confidence. The experts' statements show that the current structure generates ambiguities ("communication and decision-making do not make sense together"; "we do not know where it begins"; "ethics should be throughout the process"), that the concept of data needs to be broadened ("data is information... distinguishing what is AI from what is real") and that several terms may be difficult for teachers to understand ("measurable refers only to quantitative"; "sampling may not be understood"), which reinforces the urgency of continuous training to ensure appropriation, consistency and equity of implementation.

Closing question

What is the single most important improvement needed for this framework to function as a credible policy instrument?

The single most important improvement needed for this framework to function as a credible policy instrument is a redesign of its conceptual structure that clarifies the separation and sequencing of domains, particularly by disaggregating "Communication" and "Decision-making", making explicit a coherent progression between stages and making ethics truly cross-cutting, accompanied by structured training to ensure that teachers and other users can interpret and apply the framework with confidence. Discussions show that the framework needs to reflect the expanded notion of data as information, including veracity and AI-generated content ("data is information... distinguishing what is AI from what is real"), and that some technical terms and concepts may not be accessible without adequate training ("measurable refers only to quantitative"; questions about sampling), reinforcing that the credibility of the instrument depends both on structural consistency and on the training of the professionals who will implement it.

Main outcomes - Teachers

Teachers consider the reference framework to be **structurally** sound, easy to understand on first reading and with a progression logic aligned with pedagogical practices. The proficiency levels are particularly valued for their practical usefulness. However, the language, the formulation of the descriptors and the requirement for progression in certain cycles are aspects that limit

operational clarity. The internal articulation between domains and the position of the Ethics & Agency domain are elements that would benefit from conceptual and practical clarification. All participants requested concrete examples, linguistic simplification, and applied guidelines to support implementation.

Teachers also recognize that the proposed **domains** constitute a theoretically complete framework that is aligned with the data literacy needs of compulsory education. However, they identify internal imbalances, conceptual overlaps, and practical difficulties in the operationalization of some domains. The suggestions point to the need for conceptual clarification, greater balance between domains, and reinforcement of applied examples, in order to make the reference framework more intuitive, coherent, and functional for everyday pedagogical work.

Teachers also see the logic of **progression** in the framework as coherent, pedagogical and aligned with the natural development of students' skills. However, they identify important challenges related to the demands of certain cycles, the need for greater granularity between steps in progression and the clarity of differentiation between proficiency levels. They also mention practical difficulties arising from the material conditions of schools, which directly influence the possibility of completing some stages of progression as described in the framework. In general, although the conceptual structure is well accepted, there is a need for practical adjustments to make it more realistic, more accessible and more aligned with the diverse contexts of compulsory schooling.

In this regard, they see the table as potentially **applicable**, with clear and practical starting points. However, full implementation depends on structural conditions, time, training, resources, and the existence of support materials that facilitate the translation of domains into concrete practices. While some domains are perceived as highly useful and easy to integrate, others are considered demanding, abstract, or difficult to operate without additional support. According to teachers, the applicability of the framework is not compromised, but it requires practical mediation, contextual adaptation, and institutional support to become a consistent and equitable tool in everyday school life.

The reference framework is considered to have significant potential to support the approach to **ethical issues** and promote inclusive practices. However, for many teachers, and following on from what has been mentioned, this potential will only be realized if there is greater clarity in the descriptors, practical examples that facilitate operationalization, and training that builds confidence in dealing with complex issues such as bias, privacy and data justice. Similarly, although the framework includes references to equity, teachers believe that this principle should be more explicit and cross-cutting, with clear indications on how to adapt practices to students with diverse needs or abilities.

Thus, the ethical and equity dimension of the framework is seen as promising but still insufficiently explicit, requiring reinforcement, detailing, and practical support to ensure consistent and inclusive implementation in schools.

In general, teachers recognize the framework's potential to improve data literacy practices, but its adoption and sustainability depend on concrete structural conditions: practical training, planning time, technological resources, curriculum integration and institutional support. Without these conditions, the framework risks being yet another political document that does not translate into real changes in the classroom. In addition, factors such as teacher resistance, lack of organizational stability and resource inequalities represent significant barriers to its consistent application.

Main outcomes - Policymakers/Experts

The reference framework is recognized as coherent and adequate as a reference but needs to gain clarity in representation and terminology (definition of "data", veracity/AI), reduce/group domains and make the flow order explicit. In terms of internal logic, the **structure** is solid but requires reordering (1. Questioning; 2. Analysis; 3. Representation; 4. Communication; 5. Decision), separating Communication & Decision, renaming to "Access to data", calibrating levels per cycle and simplifying language, balancing qualitative and quantitative.

The **domains** offer a globally complete view of data literacy, but balance requires the aggregation of overlapping areas, reordering (1. Question; 2. Analyze; 3. Represent; 4. Communicate; 5. Decide after critical evaluation) and separation between "Communication" and "Decision-making". The evolution to "Access to data", cross-cutting Ethics and the explicit inclusion of AI/misinformation/veracity correct imbalances and align the framework with school practices and policy priorities. Finally, simplifying language and calibrating levels by cycle reduces complexity and reinforces applicability at the system level.

The **progression** logic is conceptually robust and has great potential for curriculum alignment. However, it requires significant adjustments to be fully coherent and flexible: clarifying the relationships between domains, simplifying the language of descriptors, balancing quantitative/qualitative, calibrating levels by cycle, and making ethics and decision-making cross cutting. In summary: coherent, promising, but in need of refinement to become realistically applicable at the national and institutional levels.

The framework has strong potential for **use** at the system level, but its direct application in a school context depends on simplification, conceptual clarification, practical examples, and gradual implementation strategies.

The framework addresses **ethical issues** but does not do so in a sufficiently cross-cutting, explicit, or operational manner. Clear references to truthfulness, AI, misinformation, consent and legitimacy of access, and accountability/reporting are lacking. Equity also needs to be addressed more explicitly, not only in terms of content, but above all in terms of feasibility of **implementation**: unequal teacher training, exclusionary technical language, and levels that are too ambitious for some cycles.

Reflection on the National Validation Workshops

The workshops held in Portugal to validate the Data Literacy Reference Framework for compulsory education revealed an overall positive assessment of the Framework by both teachers and policy makers, accompanied by clear requests for simplification, conceptual clarification and support for implementation. In summary, there is strong convergence on the pedagogical and systemic potential of the framework; at the same time, a revision is proposed focusing on specific aspects (in structure, language and materials) but which would enable a good reference framework to be converted into a consistent policy and practice tool in schools.

Evaluation of the Framework's Structure

Teachers describe the framework as **structurally sound, easy to understand** on first reading and with a progression logic aligned with pedagogical practice. They particularly value the proficiency levels for their usefulness in planning and formative assessment. On the other hand, they point out limitations in operational clarity: **technical/ambiguous language, descriptors with multiple verbs, and the perception of high demands in the 2nd cycle**. There are still doubts about the internal articulation of domains and the location of the domain 'Ethics & Agency'. All

participants agree that it would be useful to have **concrete examples**, and the advantage of **linguistic simplification and precise guidelines** to support implementation is also mentioned.

For policy makers, trainers, and researchers, **the structure is considered coherent**, but some changes are also suggested, namely **clarity in representation** (explicit order of domains) and the **separation** of Communication from Decision-making. It is also suggested that the domain of Ethics be made cross-cutting and that the meaning of "data" be clarified as "data and information", with veracity/AI and combating disinformation. It is also suggested that descriptors be adjusted by cycle, simplifying the language and balancing quantitative/qualitative. Most participants propose making the **representation of the reference framework linear** or numbering it: 1. Question; 2. Analyze; 3. Represent; 4. Communicate; 5. Decide.

Evaluation of the Framework's Content

In the case of teachers, the domains are seen as **comprehensive and theoretically complete** (technical, cognitive, and ethical). However, they point out **imbalances and overlaps** (e.g., Representation & Visualization with Communication & Decision Making; links between Analysis and Interpretation & Communication), which makes operational delimitations difficult and can lead to redundancies. Modelling & Automation emerges as the **most challenging domain** (dense terminology, distant from practices in some cycles/disciplines), prompting requests for examples.

Policy makers, trainers and researchers consider the **content to be generally complete** but suggest **merging overlapping areas and reordering the domains** (1. Questioning; 2. Analyzing; 3. Representing; 4. Communicating; 5. Deciding after critical evaluation), renaming it from 'Acquisition & Management' to 'Access to data', where collection is not central, and explicitly including truthfulness/AI/disinformation. They also consider it a priority to highlight equity as a cross-cutting principle with operational implications.

Evaluation of the Framework's Applicability

Most teachers say it would be possible to **start as early as next school year**, especially through Questioning & Problematization and familiar tasks (basic statistics, reading graphs, combating misinformation), which require fewer tools and dialogue with existing practices. However, **full implementation depends on curriculum time, technological resources** (equipment, internet connection), **practical training** (particularly for Modelling and Automation), and **support materials** (guides, examples, rubrics). In constrained contexts, certain descriptors/levels of progression may be difficult to achieve, creating asymmetries between classes and schools.

Policy makers, trainers, and researchers see **great potential for curriculum alignment and use at the education system level**, but emphasize that applicability requires simplification of language, clarification of descriptors, balance between quantitative and qualitative, adjustments by cycle, and Ethics & Decision-making as cross-cutting dimensions. They recommend **progressive implementation strategies and monitoring mechanisms** to ensure consistency and organizational learning.

Recommendations for Revisions and Enhancements

The following recommendations are based on a systematic analysis of data collected during the validation workshops with teachers and stakeholders in Portugal and are intended to guide targeted revisions that address the identified needs and priorities. The recommendations are presented as operationalized, action-oriented guidance for the further development of the framework.

1. Language and descriptors

The first line of improvement focuses on simplifying language and clarifying descriptors. To increase operationalization and facilitate interpretation by teachers, it is recommended that each descriptor use only one operative verb, formulated in short, direct sentences, supported by a common glossary that defines the key terms used throughout the reference framework. It is also important to introduce indications of the distinction between levels, specifying observable indicators that clearly differentiate between what characterizes the Initial, Intermediate and Advanced levels. In addition, it would be useful to include examples for each domain and level, presenting a typical activity accompanied by expected evidence, as well as examples of 'what counts' and 'what does not count', thereby reducing ambiguity and guiding pedagogical practice.

2. Structure and representation

In terms of conceptual structure, reorganization is recommended to increase the readability and internal consistency of the framework. A key proposal is to separate the domains of 'Communication' and 'Decision-making', placing the latter after an explicit moment of critical evaluation of the data. At the same time, the Ethics & Agency domain should take on a clearly cross-cutting nature, incorporating indicators of ethical aspects in all domains. The graphic and textual representation should also make the order of progression explicit, using a linear representation or explicit numbering of the stages. Another suggested improvement is to clarify the concept of 'data', broadening it to 'data and information' and integrating considerations on veracity, artificial intelligence and disinformation. Where appropriate, it is also recommended to rename the domain 'Data Acquisition & Management' to 'Data Access', reflecting practices where the main challenges lie in access, legitimacy and provenance, rather than in collection in a strict sense.

3. Balance between domains and clarification of boundaries

The framework would also benefit from a reinforcement of the balance and conceptual delimitation between domains. In areas where there is interdependence, such as between Representation & Communication, or between Analysis & Interpretation, it is essential to clarify the boundaries, avoiding redundancies and difficulties in operationalization. It is therefore recommended to explain how each domain differs from and interacts with the others. In the case of Modelling & Automation, seen as the most demanding domain, we suggest restructuring the internal progression, with examples by cycle and discipline, as well as introducing different types of technological tools, allowing this domain to be worked on even in contexts with few technological resources.

4. Link to the curriculum and support materials

To support implementation and promote curriculum alignment, it is recommended that an Essential Learning Matrix - Domains be created, organized by subject and school year, establishing a clear path between objectives, descriptors, activities, evidence and assessment. It is also considered essential to provide practical kits, including guides, observation grids, examples of data storytelling adapted to different subjects, and rubrics. These resources would serve as tools for operationalizing the reference framework for teaching practice, facilitating integration into different subject contexts.

5. Operationalization of ethics and equity

One area to which particular attention is recommended concerns the operationalization of ethics and equity. It is recommended that ethical indicators be integrated into the tasks proposed to students, addressing aspects such as privacy, consent, data accuracy and the identification of biases. To support this integration, guides could be produced on topics such as generative AI, disinformation and critical analysis of sources. It is important to make the principle of equity



more explicit in the descriptors, including guidelines for adaptation to different student profiles and suggesting learning alternatives, in order to ensure truly inclusive access.

6. Implementation and sustainability

Finally, to ensure effective and sustainable implementation, it is recommended to invest in practical training focused on reading and interpreting the descriptors, planning using a matrix that associates Essential Learning – Domains or formative assessment guided by proficiency levels. At the organizational level, it is important to allow time for collaborative planning and to ensure minimum internet connection and equipment requirements. The adoption of the reference framework should also be accompanied by experimentation in a practical context, allowing schools to start work in the most accessible domains (such as Questioning or Analysis) and only then move on to more complex areas, such as Modelling & Automation, with support and sharing of real examples (plans, artefacts, student work).

National Report Cyprus

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Executive Summary

This report presents the outcomes of the Cypriot validation workshops conducted in February 2026 within the DATA-READY project to examine the coherence, relevance, and implementation potential of the Data Literacy Framework (DLF) in compulsory education. Two face-to-face workshops were held at the Cyprus Pedagogical Institute in Nicosia: one with 19 policymakers, curriculum experts, and institutional stakeholders, and one with 10 primary and lower secondary teachers. Together, they provided complementary system-level and classroom-level perspectives.

Across both groups, there was **strong consensus that the Framework is conceptually robust, developmentally coherent, and aligned with competence-based curriculum design**. The structure of seven domains, three progression bands, and three proficiency levels was validated as comprehensive and suitable for cross-curricular integration. Data literacy is clearly positioned not as a narrow technical skill but as an integrated socio-cognitive and civic competence linking inquiry, analysis, communication, and ethical action.

At the same time, participants **distinguished** between conceptual strength and practical usability. While the structure is endorsed, refinements are needed to reduce terminological density, improve visual clarity, and strengthen the readability of progression expectations. Awareness, Ethics & Agency was widely perceived as a transversal principle rather than a parallel domain, and participants recommended making its cross-cutting role more explicit.

The **progression model** was considered developmentally sound, yet stakeholders emphasized that learning trajectories are non-linear and context dependent. Bands should function as flexible developmental zones rather than rigid age stages. Teachers highlighted the **absence of a preschool or kindergarten** entry point and recommended introducing an early-year's level to ensure continuity. Proficiency levels were seen as useful but should remain flexible, with stronger grounding in observable evidence. The "Advanced" level should be aspirational rather than universally expected.

Regarding **content**, the seven domains were confirmed as balanced and complete. Participants recommended targeted refinements, including stronger emphasis on data quality (reliability, validity, bias), clearer domain boundaries, developmentally staged emphasis for Modelling & Automation, and explicit clarification that digital tools support, rather than define, competence. **The non-neutrality of data should be more clearly foregrounded.**

Applicability was identified as the decisive factor for success. Both groups rejected a standalone subject model and strongly favored **integration within existing disciplines**. Questioning & Problem Framing was identified as a realistic entry point. Phased, pilot-based implementation prior to broader scaling was widely supported. Sustainable adoption depends on practice-oriented professional development, teacher ownership, and formal embedding within national curriculum and assessment structures.

The **ethical dimension** was recognized as a major strength, particularly in relation to misinformation, bias, and democratic citizenship. However, clearer operational guidance is needed on sensitive data, consent, and legal responsibilities in school contexts. **Equity** was framed primarily as a systemic issue, requiring context-sensitive rollout and safeguards against infrastructural disparities.

Overall, the Cypriot validation confirms the Framework's strong conceptual foundation and policy relevance. **No structural redesign is required.** The priority is refinement focused on usability, clearer epistemological grounding, practical exemplification, flexible progression interpretation, and institutional anchoring to ensure sustainable and meaningful implementation in compulsory education.

Organization of the workshops

Participants for the validation workshop targeting policy experts and key stakeholders were recruited through professional networks, the curriculum development agency of the Cyprus Ministry of Education, Sport and Youth (CMESY), higher education institutions, teacher training bodies, and relevant policy structures. Targeted invitations were extended to individuals with recognized expertise in curriculum design, educational research and evaluation, educational technology, pedagogy in primary and secondary education, and educational policy development.

The recruitment process resulted in the participation of 19 senior stakeholders representing a broad spectrum of educational, academic, and public administration institutions. These included the Cyprus Ministry of Education, Sport and Youth (CMESY), the Cyprus Pedagogical Institute (CPI) of the CMESY, the Centre for Educational Research and Evaluation (CPI), the Unit for Education for Sustainable Development of the CMESY, and several higher education institutions. Participants held positions involving teaching, mentoring, research, and policy advisory roles across primary, secondary, and tertiary education. Their professional profiles ensured strong alignment with system-level planning and policy-oriented decision-making processes.

Teachers from compulsory education schools were also invited to participate in a dedicated validation workshop. Participants were purposefully selected to ensure diversity and representativeness according to the following criteria: (a) inclusion of both primary and lower secondary education levels; (b) representation of multiple subject areas (e.g., ICT, Physical Sciences, Social Sciences); (c) a range of academic qualifications, from diploma holders to doctoral graduates; (d) variation in years and levels of professional experience; and (e) participation from both public and private school sectors.

Based on these criteria, the final teacher group comprised 10 educators with diverse academic backgrounds and professional profiles, enabling a pluralistic and multi-perspective discussion.

Prior to the workshops, all participants received a comprehensive preparatory package consisting of: (a) a concise overview of the Data Literacy Framework, including its rationale and theoretical foundations; (b) the main findings from the D2.1 DATA READY report, with particular emphasis on national results for Cyprus; (c) a discussion protocol tailored to each participant group, systematically presenting the six core validation dimensions of the framework; and (d) a pre-workshop validation survey, also customized for each group, designed to capture baseline perceptions and contextual information relevant to participants' specific roles and areas of expertise.

This structured preparatory process ensured that participants engaged with the framework materials in advance of the workshop discussions, thereby supporting more focused, informed, and analytically rigorous deliberations. The use of preparatory surveys to promote informed participation reflects methodological rigor, strengthens the credibility of the findings, and provides a replicable model for subsequent consultation and validation processes.

Both workshops were organized in a face-to-face format on 5 and 6 February 2026 at the Cyprus Pedagogical Institute in Nicosia. Invitations were distributed via email and included links to the project website, the full draft of the Data Literacy Framework, and an accompanying executive

summary highlighting the key components and objectives of the DATA-READY project. This approach ensured that participants were thoroughly informed about the project's scope, objectives, and preliminary findings, as well as the framework under validation, prior to the workshop sessions.

Implementation of the Workshops

Each validation workshop was conducted as a one-day, face-to-face event at the Cyprus Pedagogical Institute in Nicosia, comprising five hours of structured discussion and two hours of scheduled breaks. The workshop for teachers took place on 5 February 2026, followed by the workshop for policy experts and stakeholders on 6 February 2026.

The workshops were designed to systematically examine the proposed Data Literacy Framework across six core validation dimensions, drawing on the perspectives of teachers and stakeholders regarding structural coherence, content completeness, progression logic, practical applicability, ethical considerations, and adoption potential.

The workshop for policy experts and stakeholders convened 18 senior representatives from:

- Curriculum development specialists, educational advisors, teacher's trainers and primary and secondary education pedagogy experts from the Cyprus Pedagogical Institute and the Cyprus Ministry of Education, Sports and Youth.
- Officers of the Educational Research and Evaluation Department of the Cyprus Pedagogical Institute, and
- Higher education faculty members specialize in educational research and computer science.

Most of the participants held doctoral degrees, with academic specializations in education, educational technology, computer science, mathematics education, curriculum development, educational administration, and environmental education. This composition ensured that the deliberations benefited from multiple institutional perspectives, encompassing both theoretical considerations and practical implementation realities.

The workshop for teachers brought together 10 educators representing primary and secondary education. The participants held doctoral and master's degrees specialized in education, mathematics and statistics, computer science, environmental education and educational psychology.

In both groups, participants' reported levels of influence spanned institutional, local and national contexts, enabling examination of the framework from strategic, operational, and policy perspectives. The workshop followed a structured agenda comprising two main components: a presentation segment and a moderated discussion segment organized around the six core validation dimensions. The agenda of both workshops followed a structured format, comprising an opening session, a presentation segment, a validation-focused discussion, and a closing session.

Opening Session

- Welcome and introduction to the workshop objectives
- Ice-breaking activity to foster participant engagement

Presentation Segment

- Overview of WP2 preliminary research findings
- Presentation of national findings from the D2.1 DATA-READY report
- Introduction to the draft Data Literacy Framework

Discussion Segment

- Structured validation discussion organized around the core validation dimensions
- Closing Session
- Summary of key insights and takeaways
- Outline of next steps and explanation of the feedback process.

Presentation Part

Both validation workshops followed a common structure and methodological approach. Each began with a presentation of the DATA-READY project and preliminary research findings and was followed by a structured discussion focused on the proposed Data Literacy Framework.

During the opening phase, a concise overview of the DATA-READY project was provided, including its objectives and overall architecture, as well as the main findings from Work Package 2 and the D2.1 DATA READY report. Emphasis was placed on findings related to Cyprus, ensuring that the discussion was grounded in nationally relevant empirical evidence and context-specific insights concerning the Cypriot education system. This focus enabled participants to reflect on the framework considering realistic implementation conditions and existing institutional and pedagogical practices. The next phases of the project were also outlined, including the development of learning scenarios and the provision of teacher professional development.

Subsequently, the draft Data Literacy Framework was presented in detail, including its underlying rationale, theoretical foundations, domain structure, progression bands, and proficiency levels. Visual representations of the framework architecture were used to facilitate shared understanding prior to the discussion phase and to ensure that all participants engaged with a common conceptual reference point.

In the workshop for policy experts and stakeholders, both the presentation and the subsequent discussion primarily addressed the institutional utilization of the framework. Attention was given to its potential integration into existing curriculum development processes, teacher professional development structures, and quality assurance mechanisms, as well as to the conditions required for sustainable adoption at system level. Participants were invited to examine the strategic coherence of the framework, its alignment with national educational priorities, and the structural adjustments that might be necessary for its implementation within the Cypriot context.

In contrast, the teachers' workshop placed greater emphasis on the pedagogical application of the framework in everyday classroom practice. The discussion focused on the feasibility of implementation across compulsory education levels, its alignment with the current curriculum, differentiation strategies, and approaches to assessing student learning progression within the framework.

In both workshops, prior to the deliberative phase, a discussion protocol tailored to each participant group was presented. The protocol was organized around six core validation dimensions. This shared structure ensured methodological consistency across the two workshops, while simultaneously allowing for the articulation of distinct perspectives, systemic and institutional in the case of stakeholders, and pedagogical and practice-oriented in the case of teachers - on the same proposed framework.

Discussion Part - Teachers

This section reports the findings from the teachers' validation workshop, focusing on how clearly the framework is understood, how logically consistent it appears, and how appropriate it is for large-scale application in compulsory education. Teachers' contributions are considered not simply as reflections drawn from classroom practice, but as experiential evidence that can

inform curriculum design, professional development, and policy decisions. The discussion examines whether the framework's domains, progression stages, and proficiency descriptors form a structured yet adaptable model capable of being incorporated into existing national curricula, cross-disciplinary programs, and assessment systems without adding unnecessary workload or structural complexity.

Based on a qualitative thematic analysis of the focus group conversations, this section presents diversity of perspectives, while highlighting recurring patterns of agreement in teachers' perspectives. It identifies both the strengths of the framework and areas requiring refinement to enhance practicality, scalability, and alignment with broader educational structures. Special attention is given to views regarding the differentiation between domains, the embedding of transversal elements, such as ethics, critical data literacy, and reflective practice, and the framework's capacity to support integrative, practice-oriented learning across educational contexts. Collectively, the findings offer evidence-based guidance for future revisions, national contextualization, and the sustainable integration of the framework within compulsory education systems.

Dimension 1: Structural Clarity & Coherence

Q1. When you look at the framework, what feels clear and usable for you as a teacher, and what feels complex or difficult to navigate?

Structural Clarity and Readability

Participants expressed strong overall acceptance of the Framework's structural architecture, reinforcing its credibility as a reference model for classroom practice. The Framework was widely perceived as logically organized and conceptually coherent, with clearly delineated domains that are meaningful for educational use.

The Horizontal Role of Awareness, Ethics & Agency

The domain of Awareness, Ethics & Agency was consistently recognized as fundamental. However, many participants perceived it as a transversal dimension rather than as a standalone domain parallel to the others. This creates a structural tension: while its importance is undisputed, its positioning within the linear domain structure may generate interpretative ambiguity. The findings therefore suggest the need for a more explicit articulation of its horizontal and cross-cutting character within the model.

Non-Linearity and Interdependencies Among Domains

Several participants questioned the implicit linearity of the Framework, noting that the sequencing of domains varies across disciplinary and pedagogical contexts. The Framework was frequently described as better understood as a cyclical process or interconnected network rather than a fixed progression pathway. This perspective aligns particularly with interdisciplinary teaching and project-based learning approaches, where domains interact dynamically rather than sequentially.

Generalizability Across Educational Levels

Questions were also raised regarding the applicability of the Framework across all educational stages, including early childhood education. Although the structure is considered pedagogically sound, participants expressed concerns about its practical implementation across all grades, given time constraints, curriculum density, and institutional conditions.

Critical Perspective and the Non-Neutrality of Data

Finally, participants noted that, although ethical considerations are included, the principle that data are not neutral is not sufficiently foregrounded. The logic of critical thinking does not



consistently permeate the Framework's structure. This observation reinforces the need to strengthen the explicit theoretical positioning of critical data literacy as a foundational dimension embedded throughout the model.

Q2. Do the domains, progression bands, and proficiency levels work together in a way that makes sense for classroom use, or are there points where the structure feels confusing?

Internal Coherence of the Structural Model

Teachers generally evaluate the internal logic of the model, organized from domains to progression bands and subsequently to proficiency levels, as conceptually coherent and pedagogically meaningful. The hierarchical structure is perceived as theoretically robust and aligned with developmental logic, providing a clear organizing principle for structuring learning expectations across educational stages.

Age/Grade Alignment Ambiguity

Despite this overall coherence, participants identified uncertainty regarding the practical alignment between progression bands or proficiency levels and specific grade levels. Teachers expressed difficulty determining how the abstract structure translates into concrete classroom implementation within defined curricular timelines. The absence of explicit age/grade mapping creates interpretative variability and may hinder consistent application across schools.

Vertical Readability of Learning Expectations

A second source of ambiguity concerns the vertical articulation of learning objectives within the framework. Participants emphasized the need for clearer visibility of what is achieved at each progression stage, without requiring repeated cross-referencing across multiple sections. In its current format, expected learning outcomes are not always immediately apparent within each band, which complicates rapid pedagogical planning.

Need for Structural Reorganization and Visual Clarification

In response, teachers suggested a reconfiguration of the presentation format to enhance usability, for instance, positioning learning objectives directly beneath each progression band to facilitate immediate interpretability. This proposal is closely linked to the intended function of the descriptor matrices, which are designed to operationalize developmental progression by translating conceptual distinctions into observable and actionable classroom criteria.

Dimension 2: Domain Completeness & Balance

Q3. Taken together, do the seven domains capture what data literacy should realistically mean for students in compulsory education?

Perceived Conceptual Completeness

At the level of content, teachers generally regard the seven domains as offering a comprehensive and realistic representation of data literacy within compulsory education. The Framework is seen as sufficiently broad to address the developmental and educational needs of students across primary and lower secondary levels.

Beyond a Technical Skill Set

A key factor underpinning this positive assessment is the Framework's conceptualization of data literacy as more than a narrow technical competence. Rather than limiting the construct to procedural or technological skills, the model frames data literacy as an integrated constellation of knowledge, skills, and dispositions. It encompasses the full spectrum of engagement with data, from problem framing and question formulation, through data acquisition, analysis, and interpretation, to communication and informed action.

Integration of Ethical and Agentic Dimensions

Importantly, the explicit incorporation of awareness, ethics, and agency strengthens perceived completeness. Teachers acknowledge that the inclusion of these dimensions' positions data literacy as a socio-cognitive and civic competence, emphasizing responsible engagement, critical reflection, and informed decision-making. This broader framing aligns the Framework with contemporary educational priorities that extend beyond technical proficiency toward critical and participatory citizenship.

Q4. Are any domains overlapping, missing, or too dominant compared to others from a teaching perspective?

Refinement vs. Structural Reconfiguration

Most teachers indicated that the domains are well-defined, but they also proposed targeted refinements aimed at deepening and clarifying specific areas of the model.

Enrichment of Awareness, Ethics & Agency (AE)

Participants suggested broadening the scope of the Awareness, Ethics & Agency domain beyond a predominantly risk-oriented focus (e.g., privacy concerns). They proposed that it should also explicitly incorporate epistemological and socio-cognitive awareness, highlighting the constructive role of data in evidence-based decision-making, opinion formation, and empiricism as a foundation for knowledge. This would position data literacy not only as protective and critical, but also as generative and socially productive.

Strengthening Data Acquisition & Management (DA)

Teachers emphasized the need to reinforce the Data Acquisition & Management domain with clearer reference to data quality concepts, including reliability, accuracy, inconsistencies or measurement error, and source evaluation. Additionally, they suggested more explicit acknowledgment of the role of tools, instruments, and technological infrastructure in data measurement, storage, and processing.

Clarifying the Placement of Software-Related Skills

Another area of ambiguity concerns the categorization of software-based competencies (e.g., data representation and analysis tools). Participants requested clearer guidance on how such skills are positioned within the domain structure, to avoid conceptual confusion for teachers who tend to approach data practices through specific technological tools.

Early Integration of Bias Awareness

Teachers also proposed that bias detection and mitigation should be explicitly embedded at the stage of question formulation, rather than addressed solely at later stages of analysis or interpretation. Framing bias awareness as an early pedagogical checkpoint would reinforce critical thinking from the outset of the inquiry process.

Alignment with the Framework's Conceptual Foundations

These recommendations are consistent with the Framework's existing emphasis on cross-cutting themes and its positioning of ethics as a foundational component of competence rather than a purely technical add-on. The feedback therefore suggests evolutionary refinement rather than conceptual contradiction, reinforcing the robustness of the model while identifying areas for enhanced clarity and depth.

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. Does the progression from Primary 1 to Lower Secondary reflect how your students develop data-related skills over time?

Overall Evaluation of the Progression Model

While the progression bands were generally regarded as a useful developmental framework, participants emphasized that actual student learning trajectories are rarely linear or homogeneous.

Variability in Learning Trajectories

Participants noted that the development of data-related competencies is shaped by differences in cognitive maturity, prior exposure, socio-cultural context, and classroom conditions. As such, although the progression model is conceptually coherent, it does not always fully reflect the uneven and context-dependent nature of students' development.

Early Primary Implementation Challenges

Concerns were raised regarding the earliest years of primary education. Teachers indicated that implementation at the initial level, especially in Grade 1, may be demanding in terms of both student readiness and pedagogical feasibility. Some participants also noted the absence of an explicit preschool or kindergarten entry point, arguing that this omission creates a developmental discontinuity at the start of the progression pathway. This suggests that the lower progression bands may require additional scaffolding, differentiated guidance, and clearer articulation of how early childhood learning connects to the primary-level expectations.

Developmentally Informed Flexibility

Teachers stressed that progression bands should not be interpreted as rigid markers of linear advancement. Instead, they advocated for a clearer and more explicit linkage between progression stages and broader cognitive and developmental processes. This would allow educators greater flexibility to differentiate instruction, particularly in classrooms characterized by substantial intra-class variation, where students may demonstrate uneven levels of readiness across different domains of data literacy.

Q6. Do the proficiency levels (Starting–Intermediate–Advanced) help you understand expectations, or do they risk being confusing or unrealistic?

Perceived Usefulness for Clarifying Expectations

Teachers generally considered the proficiency levels to be helpful in clarifying learning expectations and in structuring developmental goals. The three-tier structure (Starting–Intermediate–Advanced) was viewed as conceptually coherent and potentially supportive for planning and assessment purposes.

Need for Practical Anchoring

Despite their overall usefulness, participants emphasized the need for stronger practical anchoring. Specifically, they requested clearer guidance regarding the realistic age or time span associated with each level, as well as more explicit criteria to distinguish between “expected progression” and actual “achievement.” Without such clarification, there is a risk that the levels may be interpreted inconsistently or perceived as either overly ambitious or insufficiently differentiated.

Tool for Differentiation Rather Than Rigid Categorization

Teachers stressed that proficiency levels should function as flexible tools for instructional differentiation rather than as fixed or rigid classifications. In heterogeneous classrooms, students may demonstrate varying levels of competence across domains. Therefore, the levels should enable adaptive pedagogical responses rather than impose uniform benchmarks.

Operationalization Through Descriptor Matrices and Artifacts

This perspective aligns directly with the Framework’s proposal to use descriptor matrices and indicative artifacts (learning evidence) to operationalize proficiency. Teachers highlighted the importance of demonstrating competence through observable actions, products, and documented learning processes, rather than treating proficiency levels as abstract labels. Clearer exemplification of such evidence would strengthen the practical applicability and interpretability of the levels in classroom contexts.

Dimension 4: Classroom Applicability

Q7. If you were asked to start using this framework next school year, where would you realistically begin?

Integration Within Existing Teaching Units

Teachers’ responses converged on the view that implementation should begin through integration into existing teaching units rather than through the introduction of a separate or standalone subject. Participants emphasized that adoption would be more feasible and sustainable if embedded within current curricular structures, minimizing the need for structural reorganization or additional instructional time.

Low-Threshold Entry Points

A realistic starting point was described as identifying specific lessons or activities in which data-related practices are already present, for example in Mathematics, Physical Sciences, ICT, or interdisciplinary projects, and gradually enriching these with elements drawn from the Framework. This approach allows teachers to build upon familiar pedagogical practices rather than initiating abrupt changes.

Gradual and Phased Implementation

Participants expressed a clear preference for phased implementation. Rather than attempting comprehensive coverage from the outset, teachers proposed incremental integration, beginning with selected domains or activities and expanding over time. This strategy was associated with reduced cognitive and organizational burden and was seen as more compatible with existing workload constraints.

Alignment with the Curriculum

Teachers also highlighted the importance of maintaining close alignment with the national curriculum. The introduction of tools, learning scenarios, and framework-informed practices should directly connect with curricular objectives and subject-specific content, ensuring that data literacy is perceived as enriching established instruction rather than competing with it.

Q8. What aspects of the framework feel most practically useful, and which feel hardest to apply in everyday teaching?

Practically Useful Elements

Teachers identified as most practically useful those elements of the Framework that can be directly embedded into existing lessons. They valued the possibility of designing concrete application activities, leveraging interdisciplinary connections, and using the Framework as a structured guide for lesson planning and curriculum enrichment. The model was perceived as

especially helpful when it supports teachers in reinterpreting familiar content through a data literacy lens, without requiring substantial restructuring of subject boundaries.

Time and Preparation Constraints

The most frequently cited difficulty concerned the additional time and preparation required for effective implementation. Teachers noted that meaningful integration of data literacy practices demands careful planning, adaptation of materials, and, in some cases, redesigning existing activities. Within already dense curricula and limited instructional hours, this represents a significant practical constraint.

Infrastructure and Resource Requirements

Participants also highlighted the need for appropriate tools and technological infrastructure. The availability of software, digital platforms, and measurement equipment was considered uneven across schools, creating variability in implementation capacity. This raises concerns about feasibility, particularly in contexts where resources are limited.

Assessment Challenges in a Cross-Curricular Context

Another challenge relates to assessment. Because data literacy is conceived as a transversal competence distributed across multiple subjects rather than as a discrete discipline, teachers expressed uncertainty about how to evaluate student progress coherently and systematically. The absence of a unified assessment space complicates both documentation of learning outcomes and alignment with existing grading systems.

Risk of Technocratic Implementation and Structural Constraints

Finally, teachers warned of the risk that implementation might become overly technocratic, focusing narrowly on tools and procedures rather than on meaning-making and critical engagement with data. They also emphasized structural limitations within the school system, such as limited collaboration time, weak interdisciplinary coordination, and infrastructural inequalities, that may hinder holistic and sustained application of the Framework.

Dimension 5: Ethical Robustness & Equity

Q9. How confident would you feel using this framework to address issues such as privacy, bias, fairness, and responsible data use with your students?

Ethics as a Cross-Cutting Principle

Teachers consistently conceptualized the ethical dimension as a transversal principle that should permeate all stages of working with data, rather than being treated as a final step or isolated thematic unit. This perspective aligns closely with the philosophy of the Framework, which positions Awareness, Ethics & Agency (AE) both as a distinct domain and as a horizon of responsible practice guiding all other domains.

Conditional Confidence and Need for Clarification

However, teachers' confidence in addressing issues such as privacy, bias, fairness, and responsible data use was described as context dependent. Participants expressed the need for clearer boundaries regarding what constitutes "sensitive data" within the school environment, particularly in relation to student-generated information and classroom-based data collection. Without such clarification, uncertainty may arise concerning acceptable practices.

From Rules to Critical Reasoning

Teachers further emphasized that ethical education should move beyond rule-based compliance toward the development of critical reasoning. They requested practical guidance not only on what

is permissible or impermissible, but also on why certain data practices may be ethical, unethical, or potentially harmful. This reflects a preference for fostering reflective judgement rather than merely enforcing procedural norms.

Alignment with Framework

The Framework itself incorporates explicit ethical safeguards within its application examples, including the avoidance of personal data, anonymization practices, informed consent procedures, and explicit references to fairness and the potential social consequences of data-driven actions. Nevertheless, teachers indicated that additional pedagogical scaffolding would further strengthen their confidence in enacting this dimension effectively in classroom settings.

Q10. Does the framework support inclusive practice for diverse learners, or are there areas where equity needs to be more explicit?

Inclusion as a Potential Rather Than an Explicit Design Feature

Teachers generally acknowledged that the Framework has the potential to support inclusive practice. However, they also observed that equity considerations often remain implicit rather than explicitly operationalized within the structure and descriptors of the model. While the Framework promotes inclusive approaches, the principles of equity are not always articulated in concrete pedagogical terms.

Need for Explicit Guidance in Diverse Classrooms

Participants emphasized the need for clearer guidance in contexts involving learners with diverse characteristics, including students with developmental or cognitive difficulties, learners from different linguistic or cultural backgrounds, and students with refugee or asylum-seeking status. In such cases, ethical and pedagogical dilemmas may become more complex, requiring educators who are both conceptually and practically prepared to navigate issues of fairness, representation, and sensitive data use.

Making Equity Explicit

Teachers argued that equity should be made more visible and structurally embedded within the Framework, rather than assumed as an underlying principle. This would involve articulating how data literacy practices can be adapted to diverse learning needs and clarifying how ethical and inclusive considerations intersect in classroom implementation.

Practical Mechanisms for Inclusive Implementation

Participants proposed concrete pedagogical mechanisms to translate inclusion from principle into practice. These included assigning differentiated roles within collaborative group work, offering multiple modes of representation (visual, verbal, or multimodal), and providing flexible entry points into tasks. Such strategies were seen as enabling meaningful participation for students with varying abilities and backgrounds, thereby transforming inclusion from a declarative value into an operationalized classroom practice.

Dimension 6: Adoption & Sustainability Potential

Q11. What would make this framework something you actually use, rather than another policy document?

From Conceptual Document to Practical Toolkit

Teachers consistently described meaningful adoption as contingent upon the availability of a practical toolkit. They emphasized the need for concise, adaptable learning scenarios. Examples based on authentic or realistic data; and materials that align directly with specific units of the



national curriculum. In their view, the Framework will become operational only if it supports immediate classroom translation rather than remaining at a conceptual or declarative level.

Applicability Over Comprehensiveness

Participants clearly distinguish between frameworks that are read and frameworks that are used. They indicated that they do not intend to implement the Framework in its entirety as a comprehensive package. Instead, they would selectively adopt components that are pedagogically relevant to their subject area, age group, and instructional context. Usability, therefore, depends on modularity and flexibility rather than on strict fidelity to the whole structure.

Practice-Oriented Professional Development

Teachers also underscored the importance of professional development that moves beyond theoretical familiarization. Training should be directly connected to classroom application, enabling educators to design, test, and refine activities aligned with the Framework. Without such applied support, the Framework risks remaining aspirational rather than operational.

Alignment with the Framework's Implementation Logic

This perspective aligns closely with the Framework's own implementation logic, which includes dedicated guidance sections for teachers, assessment tools, descriptor matrices, task examples, and learning artefacts. These elements function as translation mechanisms, bridging conceptual structure and classroom practice. Teachers indicated that the systematic development and dissemination of such resources would significantly enhance the likelihood of sustained and authentic use.

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Institutional and Curricular Integration

A primary concern relates to the extent of formal integration within national curricula. Teachers emphasized that unless the Framework is meaningfully embedded in official curriculum structures and aligned with learning objectives, its use is likely to remain fragmented and optional. Without institutional anchoring, implementation risks being sporadic rather than systematic.

Time Constraints and Examination-Oriented Culture

Participants identified curriculum overload, limited instructional time, and the pressure to “cover content” as significant obstacles. In systems characterized by examination-oriented priorities, opportunities for pedagogical innovation may be constrained. Under such conditions, teachers may struggle to allocate sufficient time for inquiry-based or data-rich learning activities.

Capacity, Professional Development, and Resource Availability

Teachers also highlighted the need for sustained professional development, accessible teaching materials, and structured implementation support. The absence of ready-to-use resources increases the burden on educators, particularly those who may not feel adequately prepared to design data literacy activities independently. Furthermore, rapid technological developments require continuous updating of knowledge and materials, which adds to the sustainability challenge.

Continuity Across Educational Levels

Another identified risk concerns the lack of coherence between primary and lower secondary education. Without a shared direction and explicit continuity across levels, there is a danger of fragmentation, repetition, or gaps in students' developmental trajectories.

Inequality and Symbolic Implementation

Participants warned that, in the absence of institutional support, disparities in infrastructure and access to resources may result in uneven implementation across schools, potentially reinforcing existing inequalities. Additionally, there is a risk of mechanistic or symbolic adoption, where the Framework is referenced for compliance purposes without meaningful pedagogical integration. Such practices could undermine both teacher motivation and the educational value of the Framework.

Closing question

If you could change one thing in the framework to make it more useful for teachers, what would it be?

Translating Complexity into Usable Guidance

Teachers' responses converged around a central improvement: transforming conceptual complexity into actionable pedagogical guidance without compromising theoretical integrity. Participants did not question the comprehensiveness of the Framework; rather, they emphasized the need for enhanced usability in everyday practice.

Clarification and Simplification of Terminology

A key recommendation concerned the simplification and clarification of terminology, including refinement of language, translation where necessary, and a glossary for clarifying specialized vocabulary. Teachers indicated that more accessible phrasing would facilitate quicker conceptual grasp, particularly for non-specialist educators.

Enhanced Visual Representation

Participants advocated stronger visual structuring through diagrams, infographics, and concise conceptual maps. Such visualizations would support rapid orientation within the Framework and enable teachers to construct a clearer mental model of its structure and progression logic.

Clearer Band–Level–Grade Alignment

Teachers also requested clearer guidance on the correspondence between progression bands, proficiency levels, and grade levels. Importantly, this alignment was envisioned as indicative rather than prescriptive, providing orientation while preserving pedagogical flexibility.

Concrete Examples and Authentic Scenarios

Another priority was the inclusion of practical examples and classroom scenarios based on authentic or realistic data. Teachers emphasized that illustrative tasks would significantly enhance applicability, allowing the Framework to function as a design tool rather than solely as a reference document.

Functional and Manageable Assessment Tools

Participants highlighted the need for streamlined and practical assessment mechanisms. They advocated for “lighter” tools suitable for regular classroom use, along with clearer integration of data literacy assessment within the broader student evaluation framework. Observable artifacts, structured tasks, and moderation processes were seen as valuable, provided they are operationally manageable.

Alignment with the Framework’s Implementation Direction

These recommendations are fully consistent with the existing orientation of the Framework, which already includes implementation guidance and assessment structures (e.g., artifacts, task exemplary, and moderation mechanisms). However, teachers emphasized the need for further

pedagogical mediation and presentation refinement to ensure that the Framework functions as a daily working instrument rather than as a high-density reference text intended primarily for conceptual consultation.

Discussion Part – Policymakers/Experts

Dimension 1: Structural Clarity & Coherence

Q1. From a system or policy perspective, does the framework present a clear and coherent model of data literacy for compulsory education?

Overall Structural Acceptance

Stakeholders demonstrate an overall acceptance of the Framework’s architecture. From both instructional and policy perspectives, the model is perceived as coherent, logically sequenced, and conceptually robust. The articulation of seven domains, three progression bands (P1, P2, Lower Secondary), and three proficiency levels (Starting, Intermediate, Advanced) is viewed as aligned with contemporary competence-based curriculum design. Participants recognize that the structure captures the full data engagement cycle from question formulation to ethical action, offering a shared developmental language across grades. Additionally, the clear domain delineation supports instructional planning and provides a structured reference tool for curriculum alignment.

Cognitive Load and Terminological Density

Despite this structural endorsement, participants report cognitive strain related to technical terminology, textual density and absence of rapid visual orientation tools. The terminology is often described as conceptually sound but demanding at first reading. It becomes functional only after explicit clarification. This indicates the need for linguistic mediation and simplified framing, without reducing theoretical rigor. From a systemic perspective, stakeholders suggest greater visual synthesis (schematic maps, summary diagrams), concise descriptor clustering, and clearer matrix navigation aids. The goal is to improve usability while preserving conceptual integrity.

Horizontal Role of Awareness, Ethics & Agency

The Awareness, Ethics & Agency domain is consistently recognized as essential. However, several stakeholders perceive it as a cross-cutting principle rather than a parallel domain. This structural tension reflects the Framework’s positioning of ethics as integral to competence rather than as an isolated skill. Participants recommend making its transversal function more explicit, clarifying whether it operates horizontally across all domains, and providing visual cues to signal its integrative role. Without such clarification, ambiguity may arise regarding its curricular placement and structural function.

Q2. Is the internal logic between domains, progression bands, and proficiency levels appropriate for use as a reference framework?

Perceived Internal Coherence

Participants largely confirm that the internal architecture, moving from Domains to Progression Bands and then to Proficiency Levels, is conceptually coherent and developmentally logical. Both teachers and policymakers recognize that hierarchical layering supports curriculum sequencing, reflects a clear developmental continuum, and aligns with competence-based learning design principles. From a systemic perspective, the model is considered suitable as a national reference framework, as it enables the structured articulation of learning outcomes across educational stages.

Coherent Vertical Logic

Stakeholders agree that the progression mechanism effectively connects conceptual domains, progression bands, and proficiency levels, linking what students engage with, when development occurs, and how depth of competence is demonstrated. This vertical logic is viewed as pedagogically sound and consistent with curriculum planning frameworks, as it supports gradual increases in complexity without fragmenting competence development. However, although the structure is conceptually strong, participants note that the operational visibility of this vertical coherence could be further strengthened to enhance practical usability.

Age/Grade Alignment Uncertainty

A central point of ambiguity concerns the mapping of progression bands and proficiency levels onto specific school grades. Participants express the need for clearer indicative alignment examples, illustrative grade-level mappings, and practical planning references to support classroom application. At the same time, stakeholders caution against rigid standardization, emphasizing that progression should function as developmental scaffolding rather than as fixed, grade-bound prescription. The core tension lies in balancing clearer guidance with the preservation of pedagogical flexibility.

Vertical Readability of Learning Outcomes

Teachers report difficulty synthesizing what is concretely achieved at each progression band and level without consulting multiple sections of the Framework. Participants therefore call for stronger vertical “pull-through” clarity, so that learning expectations at each band and level are immediately visible without extensive navigation. Enhancing this visibility would improve usability for lesson planning and curriculum alignment.

Role and Usability of Descriptor Matrices

The descriptor matrices are widely recognized as one of the Framework’s most valuable operational tools. Stakeholders emphasize that they provide a structured articulation of competence, support performance-based interpretation, and offer clear reference points for instructional planning. At the same time, participants note that their current density may reduce immediate usability. They recommend clearer formatting and visual hierarchy, closer alignment with curriculum performance standards, and simplified navigation to facilitate planning. The goal is to shift the matrices from dense reference tables to more accessible and practical planning instruments.

Dimension 2: Domain Completeness & Balance

Q3. Do the seven domains together provide a complete and balanced picture of data literacy at system level?

Conceptual completeness of the seven domains

Participants broadly agree that the seven domains collectively provide a comprehensive mapping of data literacy at system level. The Framework is perceived as covering the full arc of engagement with data, from question formulation and data collection to representation, analysis, interpretation, communication, and ethical reflection and action. This end-to-end structure is considered both developmentally and conceptually coherent, enabling data literacy to be understood as a structured learning continuum rather than a fragmented set of isolated skills.

Comprehensive and Balanced Coverage

Stakeholders emphasize that the model effectively addresses common imbalances observed in existing educational practice. In many systems, analytical procedures tend to receive disproportionate emphasis, while areas such as question framing, data collection design, ethical reasoning, and communicative responsibility remain underdeveloped. By incorporating all seven

domains, the Framework helps correct this imbalance, ensuring that both early-stage inquiry processes and later-stage civic implications are equally visible within the overall competence structure.

Beyond Technical Competence

A central strength identified by stakeholders is that data literacy is framed as an integrated constellation of knowledge, skills, and dispositions rather than as a purely technical or computational construct. Participants appreciate that the Framework does not reduce data literacy to tool use or statistical techniques, but instead situates competence within processes of inquiry, reasoning, and reflective judgment. This broader positioning enhances both its pedagogical relevance and its potential for cross-curricular application.

Ethical and Agentic Integration

The explicit inclusion of Awareness, Ethics & Agency significantly strengthens perceptions of the Framework's completeness. Participants highlight that this domain positions data literacy as a civic competence, integrates socio-cognitive responsibility, and connects technical processes with their ethical implications. Rather than treating ethics as an optional extension, the Framework embeds it structurally, signaling that responsible action is an integral component of competence development. This integration enhances the model's systemic legitimacy.

Alignment with Policy Priorities

Stakeholders confirm that the Framework aligns with national policy priorities, particularly in the areas of digital transformation, critical thinking, and responsible citizenship. Within the Cypriot educational context referenced in the D2.1 findings, the model is perceived as responsive to documented needs, especially in supporting students' critical engagement with digital data environments. This alignment enhances its credibility and viability as a national reference framework.

Q4. Are any domains insufficiently developed, overly complex, or misaligned with current policy priorities?

Preference for Refinement over Structural Change

Across stakeholder groups, there is broad agreement that the Framework's structure should be maintained at this stage. Participants emphasize the importance of testing the model in classroom practice before considering any redesign, highlighting the value of preserving its conceptual breadth. Rather than advocating structural consolidation or domain merging, they call for targeted refinements aimed at improving clarity and balance. The prevailing view is that the overall architecture should remain intact, with selective adjustments introduced to enhance precision and usability.

Conceptual Overlaps Between Domains

Some conceptual overlaps are identified, particularly between Representation & Visualization (RV) and Modelling & Automation (MA), and occasionally between Analysis & Interpretation (AI) and Communication & Action (CA). These overlaps are not viewed as structural weaknesses; rather, stakeholders request clearer articulation of functional boundaries to support classroom implementation. The concern focuses on operational clarity, to facilitate better understanding of specific practices, especially when learning activities naturally extend across multiple domains.

Developmental Asymmetry of Modelling & Automation

Modelling & Automation (MA) is widely perceived as developmentally demanding, particularly in the early primary grades. Participants recommend staged prioritization across progression bands, a gradual introduction of automation concepts, and differentiated emphasis based on

students' developmental readiness. Rather than diminishing the importance of the domain, stakeholders advocate proportional weighting that reflects cognitive maturity and curricular feasibility.

Strengthening Data Acquisition & Management

A frequently expressed recommendation calls for strengthening the emphasis on data quality principles within the Data Acquisition & Management domain. Stakeholders recommend placing clearer emphasis on accuracy, reliability, validity, bias, and error margins. Strengthening these elements would align the Framework more explicitly with principles of evidence-based inquiry and established standards of scientific reasoning.

Expanding Awareness, Ethics & Agency

Although the Awareness, Ethics & Agency domain is highly valued, participants suggest targeted enrichment to strengthen its conceptual depth. Proposed refinements include the explicit integration of epistemological awareness, clearer articulation of the principle that data are not neutral, embedding bias awareness at the stage of question formulation, and greater emphasis on constructive and responsible data use. These enhancements would deepen the Framework's theoretical grounding and reinforce its socio-cognitive positioning.

Clarifying the Placement of Software and Digital Tools

Participants note ambiguity regarding the positioning of digital tools across domains. Questions arise about whether tool use should be situated primarily within Modelling & Automation, how software relates to Representation or Analysis, and whether there is a risk of conflating tool proficiency with conceptual competence. Stakeholders therefore recommend clearer guidance to prevent conceptual confusion during implementation, emphasizing the importance of maintaining focus on transferable competences rather than software-specific skills....

Dimension 3: Progression Logic (Bands + Proficiency)

Q5. How well does the progression logic align with curriculum design, learning outcomes, and assessment practices in your context?

Structural Recognition

Stakeholders widely recognize the three-band progression model (P1–P2–Lower Secondary) as structurally compatible with competence-based curriculum design. The staged articulation supports curriculum sequencing, facilitates outcome-based planning, and aligns with developmental scaffolding principles. Participants describe the bands as a strong structural backbone that enables coherence across domains, learning outcomes, and assessment frameworks.

Developmental Coherence Across Bands

From a systemic perspective, the progression logic is regarded as developmentally aligned, with its gradual increase in conceptual depth and cognitive demand reflecting established curriculum design principles. The articulation of proficiency levels within each band further supports differentiated assessment, competence tracking, and clearer performance expectations. Overall, this layered structure is considered appropriate as a reference framework for national curriculum alignment.

Non-Linearity of Learning Trajectories

Despite broad endorsement of the structure, teachers emphasize that real learning trajectories are rarely linear. Competences tend to develop in spiral patterns, with skills re-emerging at increasing levels of complexity, and mastery often fluctuating across contexts. As a result,

progression is typically uneven and recursive rather than strictly stepwise. Stakeholders therefore caution against interpreting bands and levels as rigid advancement ladders and advocate instead for viewing progression as dynamic and context sensitive.

Transition Vulnerability: Primary to Secondary

The transition between Primary and Lower Secondary is identified as a potential point of structural discontinuity. Participants express concern that institutional shifts may disrupt competence continuity, curriculum fragmentation may weaken the progression logic, and differences in teacher specialization may affect implementation consistency. To preserve coherence, stakeholders recommend strengthening cross-level articulation mechanisms and ensuring smoother curricular bridging between educational stages.

Developmentally Flexible Interpretation

A frequently expressed recommendation is that progression bands should serve as pedagogical orientation zones rather than fixed advancement thresholds. Stakeholders emphasize the need for flexible interpretation, adaptation to institutional contexts, and sensitivity to classroom realities. They note that institutional conditions, teacher preparation, and technological infrastructure significantly influence feasibility, and that in early primary grades, cognitive and literacy demands remain developmentally appropriate. For these reasons, progression should be framed as indicative scaffolding rather than prescriptive sequencing.

Early Primary Implementation

Stakeholders highlighted the lack of a defined preschool or kindergarten entry point, suggesting that this gap may lead to a break in developmental continuity at the outset of the progression. These observations indicate a need for stronger scaffolding in the lower progression bands, alongside more differentiated support and clearer links between early childhood learning and primary-level expectations.

Q6. Is the progression flexible enough to accommodate national and institutional variation?

Clarification of Expectations Through Proficiency Levels

Stakeholders generally view the Starting–Intermediate–Advanced scale as an effective mechanism for clarifying expectations. The proficiency structure provides a shared language for articulating competence, supports curriculum alignment, and offers operational guidance through rubric templates and descriptor identifiers. Participants note that this layered articulation enhances the Framework’s usability as a reference model across diverse institutional contexts.

Risk of Overgeneralization and Misinterpretation

Despite its overall clarity, concerns are raised about potential overgeneralization. Stakeholders observe that progress often occurs within levels rather than strictly between them, that students may develop unevenly across domains, and that competence growth is frequently domain-specific rather than uniform. Stakeholders also caution against conflating “expected level” with “achieved mastery,” warning that proficiency labels could be interpreted as fixed normative standards instead of developmental reference points. To address this risk, they recommend explicitly framing levels as flexible developmental scaffolds rather than rigid achievement categories.

Advanced Level Realism

Attention is given to the interpretation of the “Advanced” level. Stakeholders express concern that it may be perceived as a universal expectation rather than as an aspirational benchmark, potentially creating pressure to standardize high-level performance across diverse contexts and

overlooking institutional realities and resource variability. They emphasize that “Advanced” should function as an aspirational descriptor within the developmental continuum, not as a normative endpoint required for all learners.

Accommodation of National and Institutional Variation

Participants generally agree that the progression model is structurally flexible enough to accommodate national and institutional diversity, provided it is interpreted adaptively. Its effective application depends on context-sensitive implementation, teacher professional judgment, and institutional capacity and infrastructure. The model is therefore considered adaptable, but only when used as a guiding framework rather than as a prescriptive mandate.

Operationalization Through Evidence and Artifacts

Teachers strongly emphasize the importance of grounding proficiency levels in observable evidence. They recommend incorporating concrete classroom scenarios, sample student artifacts, performance indicators, and illustrative assessment tasks to make expectations more tangible. Although such mechanisms are already anticipated within the Framework, stakeholders suggest enhancing their visibility and integration. Clear practical examples would increase realism and reduce the risk of abstract or inconsistent interpretation of the levels.

Dimension 4: Classroom Applicability

Q7. In which concrete ways could this framework be used at system level (e.g. curriculum guidance, teacher PD, quality assurance)?

Framework as Strategic Reference Instrument

Stakeholders consistently position the Framework not as a prescriptive curriculum, but as a system-level reference architecture. It is viewed as a navigational tool for curriculum reform, a mechanism for building coherence across educational stages, and a structure for competence mapping within strategic planning. The domains, progression bands, and proficiency levels together provide a macro-level framework capable of aligning policy priorities with classroom practice.

Curriculum Design and Alignment

Participants identify several concrete curriculum-related applications, including the revision or enrichment of existing subject curricula, cross-curricular competence mapping, identification of data-related gaps in syllabi, and horizontal alignment across grade levels. Rather than introducing a standalone discipline, stakeholders strongly favor integration into existing subjects. The domain-based structure enables selective embedding within areas such as mathematics, science, social studies, and language education without requiring systemic restructuring. This flexible integration model is considered both more feasible and more politically realistic.

Questioning & Problem Framing as Entry Point

Among the seven domains, Questioning & Problem Framing is identified as the most practical entry point for implementation. It requires minimal infrastructure, aligns well with existing pedagogical practices, and can be applied immediately across subjects. Structured questioning and inquiry framing can be introduced without advanced digital tools or specialized software, making this domain particularly suitable for early adoption. Participants suggest starting here to build teacher confidence and establish foundations before expanding into more technically demanding domains.

Gradual and Pilot-Based Implementation

Stakeholders strongly support a phased introduction rather than immediate, system-wide adoption. They recommend beginning with pilot implementation in selected schools, followed by gradual scaling based on evaluation findings and iterative refinement informed by classroom evidence. This incremental strategy is considered essential for safeguarding quality, building institutional capacity, and maintaining sustained teacher engagement.

Teacher Professional Development (PD)

Professional Development is identified as a central pathway for implementation. The Framework can serve as the conceptual backbone for PD programs, support competence-based training design, and provide shared terminology across training initiatives. However, stakeholders emphasize that successful uptake depends on practice-oriented training. Effective workshops should include classroom scenarios, task design examples, analysis of student artifacts, and assessment alignment exercises. Purely theoretical dissemination is considered insufficient to ensure meaningful implementation.

Q8. What implementation pathways seem realistic, and which seem problematic?

Easily Integrated Domains

Participants identify several domains as immediately actionable within existing school structures. Questioning & Problem Framing can be embedded in regular lessons through structured inquiry tasks in science, social studies, or language education, without requiring additional time or infrastructure. Small-scale classroom data collection (e.g., surveys, simple measurements, local observations) can be conducted using worksheets or basic spreadsheets. Likewise, foundational data representations, such as bar charts, tables, and simple graphs, are already present in mathematics and ICT curricula. These domains are considered realistic entry points because they build existing practices and require minimal additional resources.

High-Demand Domains

By contrast, full-scale Modelling & Automation and multi-domain project work are seen as more demanding. These require algorithmic thinking, programming environments or advanced analytical tools, extended instructional time, and coordinated planning across subjects. Implementation also depends on adequate technological infrastructure and targeted teacher training. Without structured professional development, collaborative planning time, and institutional support, participants caution that these domains risk superficial adoption rather than deep pedagogical integration.

Realistic Implementation Pathways

Stakeholders converge around three implementation strategies considered both feasible and sustainable. First, a phased and pilot-based introduction is strongly recommended. Gradual implementation through selected pilot schools would allow contextual adaptation, feasibility testing, systematic feedback collection, and iterative refinement before wider scaling. This staged approach is viewed to minimize systemic risk while building an evidence base to inform broader adoption. Second, embedding the Framework within existing subjects and curricular structures is regarded as both realistic and politically viable. Integration into current disciplinary areas avoids overloading already dense curricula, whereas introducing the Framework as a standalone subject is widely considered impractical due to structural and timetable constraints. Third, implementation is seen as more sustainable in schools that function as professional learning communities. Institutionalized peer collaboration and structured exchange among teachers are expected to strengthen shared understanding, foster reflective practice, and support long-term coherence. Collaborative school cultures are therefore identified as critical conditions for meaningful and sustained adoption.

Systemic Constraints

Participants highlight several structural barriers that may hinder holistic implementation, including curriculum overcrowding, limited instructional time, infrastructural disparities, and restricted cross-subject collaboration. In lower secondary settings, strong subject silos significantly constrain interdisciplinary application, despite broad theoretical support for cross-curricular integration.

Implementation Challenges and Risks

Certain implementation pathways are viewed with considerable caution. An immediate system-wide rollout without adequate preparatory phases is regarded as unrealistic and potentially counterproductive. Similarly, participants express reservations about technocratic or superficial approaches highlighting the risk that domains might be reduced to compliance indicators, pedagogical substance overshadowed by documentation requirements, and innovation rendered symbolic rather than meaningful. Such an approach could weaken the Framework's conceptual integrity and its broader civic orientation.

Dimension 5: Ethical Robustness & Equity

Q9. Does the framework sufficiently address ethical, legal, and societal issues related to data use in education?

Ethics as a Cross-Cutting Principle

Participants consistently describe ethics as a transversal dimension that permeates all stages of data work. Rather than being confined to a single procedural step, ethical reasoning is understood to operate across question formulation, data collection, representation, interpretation, and communication and action. This cross-cutting positioning is viewed as conceptually appropriate and well aligned with competence-based education.

Ethical Dimension as a Core Strength

Stakeholders widely recognize the inclusion of Awareness, Ethics & Agency as one of the Framework's strongest elements. Its presence distinguishes the model from purely technical competence frameworks, highlights the civic and societal implications of data work, and reinforces data literacy as a socio-cognitive competence. Participants consider this structural choice a significant added value at system level.

Conditional Confidence and Institutional Boundaries

Despite endorsing the structure, stakeholders express conditional confidence regarding implementation. They call for clearer institutional guidance on data ownership, consent and permissions, boundaries around sensitive data, and legal responsibilities within school contexts. While ethical reflection is conceptually embedded in the Framework, participants stress the need for more explicit operational guidance to ensure safe, responsible, and legally sound practice.

Critical Reasoning vs. Rule Compliance

Stakeholders emphasize that ethical engagement should not be reduced to procedural compliance. There is strong consensus that ethical competence must cultivate reflective judgment, enable students to critically evaluate data claims, and promote responsibility beyond checklist adherence. The objective is to develop reasoning capacity rather than mere rule memorization. Participants caution against turning ethics into a bureaucratic formality disconnected from authentic inquiry and meaningful learning.

Data Literacy and Democratic Citizenship

Participants strongly link data literacy to active and informed citizenship. They highlight the urgency of addressing misinformation, algorithmic bias, manipulative data representations, and the uncritical consumption of social media content. Data literacy is therefore seen not only as academic competence but as a democratic necessity. Strengthening the societal framing of the Framework would further reinforce its policy relevance and civic significance.

Q10. Are there equity or rights-based considerations that should be more explicitly addressed at policy level?

Inclusion as Potential, Not Yet Fully Operationalized

Participants acknowledge that the Framework conceptually allows for inclusive implementation. Its competence-based and multi-domain structure provides flexibility and multiple entry points. However, equity considerations are not always operationally explicit. Stakeholders suggest that inclusion should be more clearly signaled at policy and pedagogical levels to prevent implicit assumptions of uniform capacity.

Equity as a Structural, Not Only Pedagogical, Concern

Stakeholders strongly emphasize that equity is primarily a systemic implementation challenge rather than solely a classroom issue. They point to unequal institutional readiness, variability in teacher preparation, and differences in resource availability as key concerns. Without appropriate systemic safeguards, implementation risks reproducing or even amplifying existing inequalities across schools and educational contexts.

Infrastructure Disparities as Critical Barriers

Significant disparities between schools are identified in terms of digital equipment availability, connectivity quality, and access to technological tools. These infrastructural differences directly affect the feasibility of implementing domains such as Modelling & Automation and advanced data visualization. Participants warn that without compensatory policy measures, schools with limited infrastructure may face structural disadvantages in adopting the Framework effectively.

Leadership as a Mediating Factor

School leadership capacity is viewed as a decisive factor in ensuring equitable implementation. Effective leadership can mobilize resources, prioritize innovation, foster a collaborative culture, and support teacher professional development. Conversely, limited institutional leadership capacity may constrain uptake, regardless of the Framework's quality. Equity, therefore, is partly mediated by governance and organizational capacity at the school level.

Practical Inclusion Mechanisms

At the pedagogical level, participants propose several concrete strategies to strengthen inclusion, including differentiated group roles within data projects, multimodal representation options such as visual, oral, written, and digital formats, flexible entry points across proficiency levels, and scaffolded progression within domains. These approaches enable diverse learners to participate meaningfully while maintaining high competence expectations.

Need for Differentiated and Context-Sensitive Implementation

Stakeholders reject uniform, one-size-fits-all expectations and instead advocate for flexible implementation pathways, context-sensitive adaptation, and differentiated rollout models across regions and school types. They emphasize that equity should be embedded explicitly within implementation guidance rather than assumed to emerge automatically from general flexibility.

Dimension 6: Adoption & Sustainability Potential

Q11. What conditions would be necessary for this framework to achieve long-term adoption rather than short-term endorsement?

From Framework to Practical Toolkit

Participants stress that long-term adoption depends on transforming the Framework from a conceptual architecture into a practical toolkit. This requires the development of adaptable classroom scenarios, concrete implementation pathways, clear domain-specific entry strategies, and illustrative artefacts with assessment examples. Without such operational translation, the Framework risks remaining a reference document rather than becoming an applied instrument in everyday practice.

Professional Autonomy and Teacher Ownership

Stakeholders consistently underline that sustainable adoption requires strong teacher ownership. Essential conditions include space for contextual adaptation, respect for professional judgment, and flexibility in curricular integration. If the Framework is perceived as externally imposed, implementation is likely to remain superficial. Authentic integration depends on empowering educators to interpret and adapt the Framework within the realities of their teaching contexts.

Practice-Oriented Professional Development

Experiential, practice-focused professional development is identified as a critical enabling factor for successful implementation. Effective PD should actively engage teachers in designing and testing data-related tasks, facilitate feedback through collaborative reflection, and connect theoretical foundations with classroom experimentation. Participants emphasize that conceptual awareness alone is insufficient; sustained and iterative training models are necessary to build procedural confidence and pedagogical fluency over time.

Formal Institutional Embedding

Stakeholders emphasize that voluntary uptake alone cannot ensure sustainability. Long-term adoption requires formal anchoring within ministry-level policy structures, curriculum authorities, national competence frameworks, and quality assurance systems. Such institutional embedding signals strategic priority and helps secure continuity beyond individual initiatives or short-term projects.

Reform of Initial Teacher Education

Participants identify undergraduate teacher preparation as a strategic leverage point for sustainable implementation. Embedding data literacy within Initial Teacher Education programs would normalize competence expectations from the outset of the profession, reduce reliance on later in-service correction, and contribute to long-term systemic capacity building. Without integration into teacher education curricula, implementation risks remaining fragmented and uneven.

Sustained and Systematic Professional Development

Beyond initial training, sustainability requires structured, long-term professional development models. Participants recommend multi-year PD cycles, the establishment of communities of practice, cross-school collaboration, and close alignment between training content and classroom realities. Short-term workshops or awareness campaigns are viewed as insufficient to achieve lasting and meaningful change.

Interdisciplinary Structural Support

Because data literacy spans multiple domains and subjects, organizational adjustments are necessary to sustain interdisciplinary practice. Suggested structural supports include timetable coordination, dedicated time for collaborative planning, and the development of cross-subject project frameworks. Without these adjustments, interdisciplinary intentions are likely to remain aspirational rather than becoming operational realities.

Q12. What risks or barriers could prevent sustained use of the framework in schools?

Weak Institutional Anchoring

Participants identify insufficient curriculum integration as a primary risk to sustainability. If the Framework is not formally embedded within national curriculum structures, assessment systems, and ministry-level policy frameworks, its use is likely to remain fragmented and reliant on individual initiative. Without clear institutional anchoring, long-term continuity and systemic impact cannot be ensured.

Policy-Practice Disconnection

Stakeholders warn against introducing the Framework without careful consideration of contextual realities. They highlight risks such as reform fatigue among teachers, superficial endorsement without substantive change, and misalignment between policy ambition and classroom feasibility. If implementation expectations exceed institutional capacity, the Framework may be perceived yet another short-lived reform initiative rather than a sustainable policy instrument.

Time Constraints and Examination Pressure

Curriculum overload and examination-driven priorities significantly limit opportunities for experimentation. Participants note that dense syllabi reduce instructional flexibility, assessment-oriented environments discourage innovation, and teachers tend to prioritize examinable content. Without stronger alignment between the Framework and assessment practices, sustainable adoption may be undermined.

Fragmentation Across Initiatives

Another identified risk is the fragmentation of data literacy across multiple disconnected projects. Without coherent integration, efforts may remain isolated, cross-curricular coherence may weaken, and competing priorities may dilute overall impact. Sustainable implementation therefore requires a unified strategic direction rather than a series of parallel initiatives.

Resource and Training Gaps

Participants emphasize that sustained professional development and ready-to-use materials are essential for long-term implementation. Key risks include insufficient professional development programs, lack of practical implementation tools, and inconsistent support structures. Without systematic training and accessible resources, classroom-level adoption is likely to diminish after the initial phase of enthusiasm.

Overcomplexity and Accessibility Concerns

Perceived structural complexity may deter adoption if it is not supported by simplified tools and practical exemplification. Stakeholders caution that dense matrices, extensive descriptors, and abstract formulations may overwhelm practitioners unless they are accompanied by clear guides, concrete examples, and concise visual syntheses that facilitate understanding and application.

Closing question

What is the single most important improvement needed for this framework to function as a credible policy instrument?

Functional Simplification without Conceptual Loss

The most consistent recommendation is to enhance navigability and usability while preserving the Framework's theoretical robustness. Participants call for clearer structural presentation, reduced textual density, improved visual synthesis, and more practitioner-friendly formatting. The objective is not to simplify the conceptual foundations, but to improve functional accessibility and practical engagement.

Institutional Integration as Decisive Condition

Many stakeholders identify formal curricular embedding as the most decisive structural improvement. For the Framework to function credibly as a policy instrument, it must be anchored within national curriculum structures, referenced in competence standards, and connected to assessment and quality assurance mechanisms. Without such institutional integration, even a well-designed model risks remaining advisory rather than authoritative.

Expansion of Practical Scenarios

A major area for improvement concerns tangible classroom applicability. Participants emphasize the need for scenario-based examples for each domain, level-specific implementation cases, and sample artifacts with assessment illustrations. Expanding practical exemplification is viewed as the most direct way to bridge the gap between policy vision and everyday classroom practice.

Conceptual Clarification Tools

Stakeholders strongly recommend the development of a comprehensive glossary, a practitioner-friendly version of the Framework, and clearer explanations of domain boundaries. These additions would reduce interpretive ambiguity, improve clarity, and strengthen professional confidence in applying the Framework consistently.

Progression Refinement

Participants suggest reinforcing the interpretation of progression bands as flexible pedagogical zones rather than rigid age categories. Clarifying this developmental flexibility would help prevent prescriptive misinterpretation, support differentiated implementation, and align the model more closely with real and varied learning trajectories.

Pilot-Based Institutionalization

Structured piloting prior to national rollout is considered essential for establishing credibility. Pilot implementation would enable context-sensitive refinement, evidence-based adjustments, and the strengthening of stakeholder confidence. Institutionalization following validated piloting is viewed as significantly more sustainable than immediate system-wide adoption....

Main outcomes - Teachers

The teachers' validation process reveals a broadly positive evaluation of the Framework, accompanied by constructive and targeted recommendations for refinement. Overall, teachers perceive the model as conceptually robust, educationally relevant, and potentially scalable within compulsory education, if usability and systemic integration are strengthened.

Teachers express strong acceptance of the **Framework's overall structure**. It is regarded as logically organized, coherent, and meaningful for classroom practice. The domains are seen as distinct and well-defined, and the hierarchical relationship between domains, progression bands, and proficiency levels is considered theoretically sound and pedagogically meaningful. At

the same time, participants identify areas where structural clarity could be improved. Awareness, Ethics & Agency is widely understood as a transversal principle rather than a parallel domain, suggesting the need for clearer articulation of its cross-cutting role. Teachers also question the implicit linearity of the model, emphasizing that in real classroom contexts data practices are cyclical and interconnected rather than sequential. Greater visual clarity improved vertical readability of learning expectations, and clearer (though non-prescriptive) alignment between progression stages and grade levels are viewed as important refinements.

Regarding **conceptual completeness**, teachers affirm that the seven domains collectively offer a comprehensive and realistic representation of data literacy in compulsory education. The Framework is especially valued for conceptualizing data literacy as more than a technical skill set. Instead, it is understood as an integrated constellation of knowledge, skills, and dispositions that includes inquiry, interpretation, communication, agency, and ethical reflection. The inclusion of ethical and agentic dimensions strengthens the perception that data literacy is a socio-cognitive and civic competence aligned with contemporary educational priorities. Rather than calling for structural changes, teachers propose targeted refinements, such as broadening the epistemological dimension of ethics, reinforcing attention to data quality and source evaluation, clarifying the placement of software-related skills, and embedding bias awareness earlier in the inquiry process.

Regarding **progression logic**, teachers consider the developmental framework helpful as an overarching structure, yet they emphasize that student learning trajectories are uneven and context dependent. The progression bands are seen as conceptually coherent, but not always reflective of classroom realities, particularly in the earliest years of primary education where additional scaffolding may be required, while the absence of an explicit kindergarten or preschool entry point is viewed as creating a developmental gap at the beginning of the learning continuum. Participants stress that progression should be interpreted flexibly, allowing differentiation in heterogeneous classrooms rather than implying rigid, linear advancement. Similarly, proficiency levels are viewed as useful for clarifying expectations, but they require stronger practical anchoring through clearer criteria, realistic age indications, and observable learning artefacts. Teachers emphasize that these levels should function as adaptive tools for differentiation rather than fixed classifications.

In terms of **classroom applicability**, teachers strongly advocate for embedding the Framework within existing subjects rather than introducing it as a standalone discipline. Sustainable implementation is associated with gradual, phased integration through low-threshold entry points in areas such as Mathematics, Science, ICT, or interdisciplinary projects. Close alignment with national curriculum objectives is considered essential, as data literacy should enrich and extend established instruction rather than compete with it.

With respect to **practical constraints and systemic barriers**, despite conceptual endorsement, teachers identify significant barriers to sustained use. Time constraints, curriculum overload, examination-oriented systems, uneven access to technological infrastructure, and limited opportunities for interdisciplinary collaboration all pose challenges. The cross-curricular nature of data literacy complicates assessment, and the absence of unified evaluation mechanisms may hinder systematic implementation. There is also concern that implementation could become overly technocratic if it focuses narrowly on tools and procedures rather than critical engagement and meaning making.

Ethics is widely recognized as a foundational, cross-cutting principle within the Framework. Teachers appreciate the explicit attention to privacy, fairness, and responsible data use, but they request clearer guidance on what constitutes sensitive data in school contexts and stronger emphasis on critical reasoning beyond rule compliance. Similarly, while the Framework is seen

as supportive of inclusive practice, equity considerations are often perceived as implicit rather than explicitly operationalized. Teachers call for clearer articulation of inclusive strategies and practical mechanisms for differentiation in linguistically, culturally, and cognitively diverse classrooms.

Across all dimensions, a consistent message emerges regarding the conditions for **sustainable adoption**. Teachers distinguish between a framework that is read and one that is used. For the Framework to become a living instrument of practice, it must evolve into a practical toolkit supported by ready-to-use scenarios, authentic examples, modular design, practice-oriented professional development, and manageable assessment tools. Without formal curricular integration and institutional support, implementation risks remaining fragmented, symbolic, or uneven.

In conclusion, teachers validate the Framework as conceptually strong, educationally relevant, and aligned with contemporary understandings of critical and civic data literacy. Their feedback does not call for structural redesign but for evolutionary refinement. The central priority is to translate conceptual sophistication into accessible pedagogical guidance, ensuring that the Framework functions not merely as a reference document, but as a sustainable and effective instrument of everyday classroom practice.

Main outcomes - Policymakers/Experts

The policymakers' and experts' validation process indicates strong strategic endorsement of the Framework, alongside clear conditions for strengthening its usability, institutional anchoring, and long-term sustainability. Overall, stakeholders perceive the model as conceptually robust, aligned with competence-based curriculum design, and viable as a national reference framework, provided that practical accessibility and system-level integration are enhanced.

Regarding **structural clarity and coherence**, stakeholders broadly endorse the Framework's architecture as coherent, logically sequenced, and aligned with competence-based curriculum design. The configuration of seven domains, three progression bands, and three proficiency levels is considered suitable as a national reference structure that supports curriculum alignment across educational stages. However, concerns are raised about cognitive load caused by terminological density and limited visual orientation. Participants recommend clearer visual synthesis, streamlined descriptor presentation, improved matrix navigation, and more explicit articulation of the transversal role of Awareness, Ethics & Agency to reduce structural ambiguity while preserving conceptual rigor.

With respect to **structural clarity and coherence**, stakeholders broadly endorse the Framework's architecture as coherent, logically sequenced, and aligned with competence-based curriculum design. The configuration of seven domains, three progression bands, and three proficiency levels is considered suitable as a national reference structure supporting curriculum alignment across stages. At the same time, concerns are raised about cognitive load caused by terminological density and limited visual orientation. Clearer visual synthesis, streamlined descriptors, improved matrix navigation, and more explicit articulation of the transversal role of Awareness, Ethics & Agency are recommended to enhance usability without compromising conceptual rigor.

In relation to **domain completeness and balance**, policymakers and experts affirm that the seven domains provide a comprehensive and balanced representation of data literacy, covering the full cycle from inquiry to ethical action. The Framework is valued for correcting curricular imbalances and for framing data literacy as an integrated socio-cognitive and civic competence rather than a purely technical skill set. Instead of structural redesign, stakeholders propose targeted refinements, including clearer functional boundaries between overlapping domains,



staged emphasis for developmentally demanding areas such as Modelling & Automation, stronger attention to data quality principles, deeper epistemological grounding of ethics—especially the non-neutrality of data—and clearer positioning of digital tools to avoid conflating software use with conceptual competence.

Considering **progression bands and proficiency levels**, the model is viewed as developmentally coherent and compatible with curriculum sequencing and assessment frameworks. The vertical linkage between domains, bands, and proficiency levels is considered appropriate for system-level reference. Nevertheless, stakeholders emphasize that learning trajectories are non-linear and context-dependent; progression should therefore operate as flexible scaffolding rather than rigid sequencing. The progression bands are generally regarded as conceptually sound; however, they do not always align with classroom practice, especially in the early primary years where greater scaffolding is often needed. In addition, the lack of a defined entry point for kindergarten or preschool is perceived as leaving a gap at the start of the learning continuum. Moreover, greater at-a-glance readability of expectations and illustrative, non-prescriptive alignment with grade levels are recommended. Proficiency levels are regarded as useful and adaptable, but “Advanced” should remain aspirational rather than universally required, and all levels should be more clearly grounded in observable evidence.

From the perspective of **classroom applicability and implementation pathways**, the Framework is positioned as a strategic reference instrument rather than a standalone subject. Integration within existing disciplines is strongly preferred. Questioning & Problem Framing is identified as a feasible entry point, whereas more demanding domains require sufficient infrastructure, instructional time, cross-disciplinary coordination, and targeted professional development. Stakeholders strongly advocate phased, pilot-based implementation before broader scaling. Sustainable adoption depends on transforming the Framework into a practical toolkit supported by concrete scenarios, entry strategies, artifacts, assessment illustrations, teacher ownership, ongoing professional learning, and formal curricular embedding.

Regarding the **ethical dimension**, stakeholders recognize ethics as one of the Framework’s strongest elements, positioning data literacy as essential for democratic citizenship in contexts shaped by misinformation, algorithmic bias, and digital influence. Ethics is understood as a transversal principle embedded across all domains. However, clearer institutional guidance is required on consent, data ownership, legal responsibilities, and the handling of sensitive data in school contexts. Participants emphasize that ethical competence should cultivate critical reasoning and reflective judgment rather than procedural compliance.

In terms of **sustainability**, long-term viability depends on strong institutional anchoring within curriculum structures, assessment systems, and quality assurance mechanisms. Equity is framed as a systemic concern, as disparities in infrastructure, leadership capacity, and teacher preparation may result in uneven implementation unless inclusion is explicitly embedded in policy guidance and rollout strategies are context sensitive. Sustained professional development, integration into Initial Teacher Education, and avoidance of technocratic or compliance-driven adoption are considered essential to prevent symbolic implementation and to secure the Framework’s credibility as a lasting policy instrument.

Reflection on the National Validation Workshops

Evaluation of the Framework’s Structure

Across both workshops, the Framework’s structure is strongly endorsed. Teachers and policymakers consider it conceptually robust, logically organized, and aligned with competence-based curriculum design. The architecture, seven domains, three progression bands, and three proficiency levels, is seen as coherent and developmentally sound, capturing the full data

engagement cycle from inquiry to ethical action and offering a shared structural language across educational stages.

Both groups emphasize refinement rather than redesign. Teachers focus on classroom usability, requesting clearer vertical readability and more immediate visibility of expectations within each band and level. Policymakers stress navigability at system level, highlighting cognitive load, terminological density, and limited visual synthesis. There is consensus that improved formatting, clearer descriptor clustering, and schematic visual tools would enhance usability without reducing conceptual rigor.

A central structural issue concerns Awareness, Ethics & Agency. Although universally valued, it is widely perceived as transversal rather than parallel to the other domains. Both groups recommend making its cross-cutting role more explicit conceptually and visually to avoid ambiguity in curriculum design and policy interpretation.

Participants also question the model's implicit linearity. Teachers note that competence develops in a spiral fashion and unevenly in practice; policymakers similarly caution against rigid sequencing. Progression bands are therefore viewed as developmental scaffolds rather than fixed advancement stages.

Alignment between bands, proficiency levels, and grade stages remains an area of constructive tension. Teachers request clearer planning guidance, while policymakers call for indicative (not prescriptive) alignment examples. Both stress the need to balance clarity with flexibility.

Finally, the descriptor matrices are recognized as essential operational tools but are considered dense and not immediately accessible. Streamlined presentations, stronger visual hierarchy, and improved at-a-glance coherence are recommended so they function as practical planning instruments rather than purely reference tables.

Overall, the workshops show strong convergence: the Framework's structure is validated as credible and coherent. The priority is not architectural change, but enhanced clarity, visual coherence, and practical interpretability to support both classroom use and system-level application.

Evaluation of the Framework's Content

Across both workshops, the content of the Framework is widely validated as comprehensive and well-balanced. Teachers and policymakers agree that the seven domains collectively provide a complete representation of data literacy, covering the entire cycle from question formulation and data acquisition to analysis, communication, and ethical action. The model is seen as correcting common curricular imbalances by giving equal visibility to inquiry processes, interpretation, communication, and civic responsibility.

A shared strength identified by both groups is that data literacy is framed not as a narrow technical skill set but as an integrated combination of knowledge, skills, and dispositions. Participants value its socio-cognitive and civic orientation, particularly the explicit integration of Awareness, Ethics & Agency. This inclusion positions data literacy as connected to democratic citizenship, critical reasoning, and responsible engagement with digital environments shaped by misinformation and algorithmic bias.

Rather than calling for structural change, stakeholders recommend targeted content refinement. Teachers suggest broadening the epistemological dimension of ethics, making the non-neutrality of data more explicit, embedding bias awareness earlier in the inquiry process, and strengthening attention to data quality concepts such as reliability, validity, and source evaluation. Policymakers echo these recommendations, emphasizing deeper grounding in evidence-based

reasoning and clearer articulation of conceptual boundaries between domains where overlaps occur (e.g., representation, modelling, analysis, and communication).

Modelling & Automation is recognized as developmentally demanding, particularly in early grades, and may require staged emphasis across progression bands. Participants do not question its importance but recommend proportional weighting aligned with cognitive readiness and institutional feasibility.

Another recurring theme concerns the placement of digital tools. Both groups caution against conflating software proficiency with conceptual competence and call for clearer guidance on how tools support, rather than define, domain learning.

In summary, the workshops demonstrate strong convergence regarding the Framework's content: it is perceived as conceptually complete, balanced, and aligned with contemporary educational and policy priorities. The central recommendation is evolutionary enrichment, deepening epistemological clarity, strengthening data quality principles, clarifying domain boundaries, and reinforcing the civic dimension, while preserving the model's comprehensive scope and integrity.

Evaluation of the Framework's Applicability

Across both workshops, applicability emerges as the decisive condition for meaningful adoption. While the Framework is conceptually endorsed, both teachers and policymakers stress that its value depends on how effectively it translates into classroom and system-level practice.

Teachers consistently emphasize integration within existing subjects rather than the creation of a standalone discipline. Embedding data literacy in Mathematics, Science, ICT, language education, and interdisciplinary projects is seen as realistic and sustainable. Policymakers align with this view, positioning the Framework as a strategic reference architecture for curriculum enrichment and cross-curricular alignment rather than as an additional subject. Questioning & Problem Framing is widely identified as the most feasible entry point due to its low infrastructural demands and compatibility with existing pedagogy.

Both groups strongly support phased and pilot-based implementation. Gradual scaling through selected schools is viewed as essential for contextual adaptation, feasibility testing, and evidence-informed refinement before broader rollout. Immediate system-wide adoption is considered unrealistic and potentially counterproductive.

Professional development is identified as a central applicability mechanism. Teachers call for practice-oriented training that includes concrete classroom scenarios, task design, assessment alignment, and analysis of student artifacts. Policymakers similarly stress that theoretical dissemination is insufficient; sustained, experiential professional learning is necessary to build confidence and procedural fluency.

At the same time, significant constraints are acknowledged. Teachers highlight time pressure, curriculum overload, examination priorities, and limited interdisciplinary collaboration. Policymakers point to systemic barriers such as infrastructural disparities, uneven institutional readiness, and fragmented initiatives. Domains such as basic inquiry and data representation are viewed as immediately implementable, whereas Modelling & Automation and multi-domain projects require stronger technological infrastructure, coordinated planning, and targeted support.

Assessment presents a further challenge. Because data literacy is cross-curricular, evaluating progress coherently across subjects remains complex. Both groups emphasize the need for manageable tools, observable artifacts, and clearer alignment with existing assessment systems to prevent superficial or symbolic implementation.

In summary, there is strong convergence: the Framework’s applicability depends on modular integration, pilot-based rollout, practice-oriented professional development, institutional support, and realistic alignment with curriculum and assessment structures. Without these enabling conditions, adoption risks remaining fragmented or compliance-driven rather than pedagogically meaningful and sustainable.

Recommendations for Revisions and Enhancements

Below is a consolidated and highly specific set of recommended revisions, organized by structural, content, operational, and policy dimensions. The overarching revision priority is to enhance functional accessibility, pedagogical mediation, and institutional embedding while preserving theoretical depth and conceptual coherence. The goal is not structural redesign but systematic refinement that strengthens interpretability, operational clarity, and sustainable integration at both classroom and policy levels.

1. Explicit Articulation of the Transversal Role of Awareness, Ethics & Agency

The domain of Awareness, Ethics & Agency (AE) should be structurally repositioned to reflect its cross-cutting function. While currently presented as a parallel domain, stakeholder feedback consistently interprets it as a transversal principle. The revised framework should

- Visually represent AE as operating horizontally across all domains (e.g., layered or overlay model).
- Include explicit structural language clarifying that ethical reasoning permeates question formulation, data collection, analysis, interpretation, and communication.
- Embed cross-references to AE within each domain descriptor to reinforce its integrative function.

2. Enhancement of Navigability and Reduction of Cognitive Load

Although conceptually coherent, the framework’s current presentation generates cognitive strain due to terminological density and descriptor volume. Revisions should include:

- A concise visual synthesis (conceptual map or schematic diagram).
- A two-page structural overview summarizing domains, bands, and proficiency levels.
- Reformatting descriptor matrices using clearer hierarchy, reduced textual density, and bullet-pointed competence indicators.
- Clustered descriptors to avoid repetition across progression bands.

3. Improved Vertical Readability of Learning Expectations

To support practical planning, expected outcomes within each progression band should be immediately visible. Recommended revisions include:

- Summary can-do statements under each band (e.g., “Students at this stage can...”).
- Consolidated band-level outcome boxes describing cumulative expectations.
- Reduced need for cross-referencing across sections to understand developmental progression.

4. Indicative Alignment Between Bands, Levels, and Grades

While maintaining flexibility, the framework should provide indicative (non-prescriptive) examples linking progression bands to typical grade ranges. Such alignment should function as orientation rather than prescription, explicitly emphasizing developmental scaffolding over rigid age-based categorization.

5. Strengthening the Epistemological Dimension

The principle that data is not neutral should be more explicitly foregrounded. Revisions should:

- Integrate bias awareness at the stage of question formulation.
- Include descriptors addressing assumption recognition, perspective awareness, and constructed nature of datasets.
- Strengthen references to epistemic responsibility within ethical reflection.

6. Reinforcement of Data Quality within Data Acquisition & Management

The framework should more explicitly incorporate foundational data quality concepts, including:

- Reliability
- Validity
- Accuracy
- Measurement error
- Sampling limitations
- Source credibility
- Representativeness

Concrete classroom illustrations contrasting strong and weak data quality practices would operationalize these principles.

7. Clarification of Domain Boundaries

To address perceived overlaps (e.g., Representation & Visualization vs. Modelling & Automation; Analysis & Interpretation vs. Communication & Action), revisions should:

- Include brief boundary clarifications within each domain.
- Provide a comparative table specifying primary functional focus.
- Clarify the distinction between conceptual competence and applied output.

8. Clarification of the Role of Digital Tools

The framework should explicitly state that digital tools serve competence rather than define it. Revisions should:

- Emphasize conceptual understanding as primary.
- Provide low-tech and high-tech implementation examples.
- Avoid conflating software proficiency with domain mastery.

9. Developmentally Sensitive Positioning of Modelling & Automation

Given concerns about cognitive demand in early grades, staged emphasis across progression bands is recommended. Early primary levels should prioritize logical structuring and pattern recognition, with algorithmic reasoning gradually introduced in later stages.

10. Reframing Proficiency Levels as Developmental Scaffolds

The Starting–Intermediate–Advanced scale should be explicitly framed as developmental guidance rather than normative categorization. In particular:

- “Advanced” should be described as aspirational.
- Clear differentiation between expected progression and demonstrated mastery should be articulated.

11. Introduce a preschool / early years entry point

Establish a formal entry point for preschool and early childhood education by incorporating a clearly defined kindergarten level within the progression structure, acknowledging that

foundational practices such as questioning, sorting, comparing, and simple representation are already present prior to primary school. This addition would address the developmental discontinuity identified at the beginning of the framework.

12. Integration of Observable Performance Indicators

Each proficiency level should include:

- Observable behavioral indicators.
- Sample student artifacts.
- Illustrative assessment tasks.
- Rubric-aligned descriptors.

This would reduce abstraction and strengthen operational clarity.

13. Explicit Recognition of Non-Linearity

A structural note should clarify that competence development is spiral, recursive, and domain specific. This prevents misinterpretation of progression as uniform or strictly sequential.

14. Development of a Practical Implementation Toolkit

To transition from conceptual framework to operational instrument, a companion toolkit should include:

- Domain-specific classroom scenarios per progression band.
- Adaptable task templates aligned with curriculum subjects.
- Authentic or realistic data examples.
- Lightweight assessment instruments.
- Sample student artifacts demonstrate progression.

15. Provision of Low-Threshold Entry Strategies

An implementation guide identifying realistic entry points, particularly through Questioning & Problem Framing, should be developed. Minimal-resource scenarios should be included to accommodate infrastructural variability.

16. Assessment Integration Guidance

Cross-curricular assessment recommendations are necessary to prevent fragmentation. Suggested additions include:

- Formative assessment templates.
- Moderation guidelines.
- Alignment examples with existing grading systems.

17. Operationalization of Ethical Safeguards

The framework should include clearer guidance regarding:

- Sensitive data definitions in school contexts.
- Consent and anonymization procedures.
- Data ownership boundaries.
- Classroom case studies illustrating ethical dilemmas.

18. Strengthening Civic Orientation

The civic implications of data literacy should be further elaborated, particularly in relation to misinformation, algorithmic bias, manipulative visualization, and democratic participation.

19. Explicit Integration of Equity Principles

Equity considerations should be structurally embedded rather than implied. Revisions should:

- Include an explicit inclusion statement.
- Provide differentiation strategies within task examples.
- Offer multimodal participation pathways.
- Incorporate scaffolded entry points for diverse learners.

20. Formal Curriculum Integration

The framework should be cross-referenced with national curriculum objectives, competence standards, and quality assurance systems to ensure systemic legitimacy.

21. Pilot-Based Validation Prior to Scaling

Structured pilot implementation should precede national rollout, allowing contextual adaptation and evidence-informed refinement.

22. Sustained Professional Development Model

Long-term sustainability requires:

- Multi-year professional development cycles.
- Practice-based workshops.
- Communities of practice.
- Integration into Initial Teacher Education.

23. Prevention of Technocratic Adoption

Explicit caution should be included against compliance-driven or box-ticking implementation. Emphasis must remain on pedagogical meaning-making rather than procedural documentation.

Final Outcomes

Through a qualitative cross-national thematic synthesis of the five country summaries on the Framework Structure, Content and Applicability dimensions (presented in previous sections), a consolidated matrix was produced, based on the following steps:

- Close reading each national summary on the framework’s dimensions to identify common themes.
- Theme extraction (9 categories) which was based strictly on explicit statements in the texts.
- Country-by-theme mapping, where each theme was marked per country as “explicitly mentioned [✓]”, “implicitly mentioned [(✓)]”, or “not mentioned [-]”.

The consolidated matrix presents how the Framework’s dimensions was evaluated across Greece, Germany, Poland, Portugal, and Cyprus. By organizing the findings into themes, the matrix makes visible both the strength of convergence and the areas of contextual differentiation.

Framework Structure

Two themes demonstrate **full convergence across all five countries: the validation of the Framework’s structural coherence and legitimacy, and the recognition of a usability gap between reference-level clarity and classroom-level application.** This indicates strong confidence in the architectural foundation, combined with a shared call for improved operational readability.

A second tier of themes shows **high convergence, particularly around progression logic and the broader tension between clarity and flexibility.** Several countries question implicit linearity and emphasize the need for developmental flexibility and adaptable grade alignment.

Moderate convergence appears in themes related to domain articulation, terminology and conceptual positioning, visual navigability, and the **transversal role of Awareness, Ethics & Agency.** These findings suggest refinement needs rather than structural instability.

Finally, the need for **concrete exemplification** emerges as a more context-specific theme, particularly emphasized in Portugal.

#	Theme	GR	DE	PL	PT	CY
1	Structural Coherence & Conceptual Legitimacy <i>Across countries, the framework’s architecture is considered conceptually sound, organized, and aligned with competence-based education. No major redesign of the framework’s logic is requested.</i>	✓	✓	✓	✓	✓
2	Structural Usability Gap (Reference vs Implementation) <i>The framework works well as a theoretical reference but is harder to navigate in classroom practice. Suggestions to add a “How to Use the Framework” section, improve vertical readability and provide planning guidance examples.</i>	✓	✓	✓	✓	✓
3	Domain Architecture & Internal Articulation <i>While domains are accepted as comprehensive, their internal boundaries are sometimes unclear. Overlaps and redundancies reduce operational clarity. Suggestions for clarify domain boundaries, reduce overlapping descriptors, add short “Domain Distinction Notes” to improve differentiation.</i>	✓	✓	(✓)	✓	(✓)
4	Clarity-Flexibility	✓	✓	(✓)	(✓)	✓

#	Theme	GR	DE	PL	PT	CY
	<i>Stakeholders want clearer guidance but also fear over-standardization. The framework must balance structure with adaptability. Suggestions for explicitly state design principles structured but adaptable, avoid rigid sequencing language and mark examples as indicative only.</i>					
5	Progression Logic & Developmental Flexibility <i>Bands and levels are endorsed but perceived as potentially too linear or rigid, especially across national grade systems. Suggestions to reframe bands as developmental zones, clarify non-linearity and provide indicative (not prescriptive) grade alignment.</i>	✓	✓	-	(✓)	✓
6	Awareness, Ethics & Agency as Transversal Dimension <i>Ethics is valued, but stakeholders see it as cross-cutting rather than parallel to other domains. Its current placement may create ambiguity. Suggestions for reposition AE visually as transversal dimension, embed ethical indicators within all domains and clarify its cross-domain function.</i>	✓	-	-	✓	✓
7	Terminology, Conceptual & Definition Clarity <i>Ambiguity in definitions (especially “data”), dense terminology, and unclear conceptual distinctions reduce accessibility. Suggestions to add a glossary, clarify definition of “data”, reduce abbreviation use and simplify descriptor language.</i>	-	✓	✓	✓	✓
8	Visual Representation & Navigability <i>Dense descriptor matrices and lack of schematic clarity create cognitive load. Suggestions for redesign schematic visualization, improve matrix formatting and strengthen visual hierarchy and domain signaling.</i>	✓	-	-	✓	✓
9	Practical Guidance & Exemplification <i>Some structural elements feel abstract without examples. Teachers request operational anchors. Suggestions to add 2-3 cross-domain lesson examples, provide sample vertical progression pathway and include planning prompts per domain.</i>	-	✓	-	✓	(✓)

Framework Content

Across all five countries, participants characterize the Framework as **comprehensive, theoretically grounded, and well aligned with contemporary understandings of data literacy**. The seven domains are widely recognized as capturing the full cycle of data engagement, from inquiry and acquisition to analysis, communication, ethical reflection, and civic action, while integrating technical, cognitive, and socio-civic dimensions.

However, the validation also identifies convergent areas for targeted refinement. A central issue concerns the **conceptual precision of “data”**. Participants highlighted ambiguity in its definition, insufficient distinction from related constructs such as information or digital competence, and limited explicit integration of emerging developments such as artificial intelligence, algorithmic bias, big data, and disinformation. Strengthening definitional clarity and future-proofing the conceptual framing are therefore seen as priorities.

Ethics and civic responsibility are strongly valued but perceived as insufficiently operationalized. Several countries call for deeper epistemological grounding, clearer articulation of fairness, power relations, and equity implications, and stronger integration of data quality



principles such as reliability, validity, and source evaluation. The aim is to move from general ethical awareness toward structured reflective engagement.

A further recurring concern relates to **Modelling & Automation**. While its inclusion is widely supported, it is regarded as developmentally demanding and unevenly feasible across educational stages. Stakeholders recommend staged emphasis and clearer differentiation between foundational transversal competences and more advanced analytical components.

#	Theme	GR	DE	PL	PT	CY
1	<p>Conceptual Completeness Validated</p> <p><i>Across all countries, the framework’s content is seen as comprehensive and theoretically well-founded. The seven domains are perceived as covering the entire data literacy cycle and integrating technical, cognitive, ethical, and civic dimensions. No country questions its overall scope. Suggestions to preserve the full scope of domains, add a brief content-positioning statement reinforcing their integrated, socio-cognitive and civic orientation.</i></p>	✓	✓	✓	✓	✓
2	<p>Ethics & Civic Dimension Requires Deepening</p> <p><i>Ethics is valued but considered too general. Participants request stronger operationalization, deeper epistemological grounding, and clearer treatment of power, bias, inequality, and disinformation. Suggestions to embed fairness, equity, and bias analysis across domains, move from general ethical statements to operational descriptors and integrate AI, algorithmic bias, and misinformation explicitly.</i></p>	(✓)	✓	(✓)	✓	✓
3	<p>Definition & Conceptual Clarity of “Data”</p> <p><i>Stakeholders identify ambiguity regarding what counts as “data,” its distinction from information, and its societal role. Conceptual grounding is seen as insufficiently explicit. Suggestions to provide a precise definition of “data,” clarify its relationship to information, digital competence, and statistical literacy and include explicit reference to contemporary data environments (AI, big data, algorithms).</i></p>	✓	✓	(✓)	✓	(✓)
4	<p>Data Quality & Epistemological Depth</p> <p><i>The framework should strengthen critical engagement with data quality and the socio-political nature of data. Suggestions to integrate data quality explicitly across domains, embed epistemological reflection early in inquiry processes and highlight non-neutrality of data.</i></p>	(✓)	✓	(✓)	(✓)	✓
5	<p>Core vs Advanced Competence Differentiation</p> <p><i>Participants request clearer distinction between foundational transversal competences and more advanced analytical or technical competences. Suggestions to identify “core competences for all learners”, mark advanced competences explicitly and provide indicative prioritization guidance.</i></p>	✓	✓	✓	(✓)	(✓)
6	<p>Modelling & Automation Developmental Demands</p> <p><i>While accepted as important, this domain is seen as cognitively demanding and not always feasible in early grades or across disciplines. Suggestions to introduce staged emphasis across progression bands, clarify proportional weighting and provide practical examples to support feasibility.</i></p>	✓	✓	-	✓	✓
7	<p>Domain Overlaps & Redundancies</p> <p><i>Content boundaries between domains are sometimes blurred, especially between Representation, Communication, Analysis, and Modelling. This affects clarity and implementation. Suggestions to review and streamline overlapping</i></p>	(✓)	✓	-	✓	✓



	<i>descriptors, clarify conceptual boundaries between adjacent domains and possibly merge or reorder where pedagogically justified.</i>					
8	<p>Need for Exemplification & Contextualization</p> <p><i>Some content elements appear abstract or demanding without concrete examples, particularly for technically dense domains. Suggestions to provide cross-domain teaching examples, add illustrative cases (e.g., civic data scenario) and include vertical progression exemplars for demanding domains.</i></p>	(✓)	✓	✓	✓	(✓)

Framework Applicability

Across all five countries, participants emphasize that the Framework should function as an **embedded, cross-curricular competence** rather than as a standalone reform. Integration within existing subjects, such as Mathematics, Science, ICT, and interdisciplinary projects, is considered the most realistic pathway. Immediate full-scale implementation is widely viewed as impractical. Instead, **phased, pilot-based rollout and incremental scaling** are recommended to allow contextual adaptation and evidence-informed refinement.

A dominant cross-national finding concerns **institutional and structural constraints**. Curriculum overload, time pressure, infrastructural disparities, limited interdisciplinary collaboration, and governance fragmentation are consistently identified as major barriers. Applicability is therefore framed less as a question of conceptual validity and more as a matter of systemic feasibility.

Teacher capacity emerges as the decisive enabling condition. Participants across contexts stress that professional development must move beyond theoretical dissemination toward sustained, practice-oriented training that includes concrete classroom scenarios, task design, assessment alignment, and reflective engagement. Without this support, implementation risks becoming superficial.

Finally, stakeholders **differentiate between domains that are immediately implementable**, such as questioning, problem framing, and basic representation, **and more demanding areas** like Modelling & Automation, which require targeted support and infrastructural readiness.

#	Theme	GR	DE	PL	PT	CY
1	<p>Integration within Existing Curriculum</p> <p><i>Applicability is realistic only if the Framework is embedded within existing subjects and curricular structures. Introducing it as a separate subject or additional reform is widely rejected. Suggest position the Framework explicitly as cross-curricular, provide subject-mapping examples (Math, Science, Language, ICT) and avoid policy framing that suggests a new standalone discipline.</i></p>	✓	✓	✓	✓	✓
2	<p>Structural & Institutional Constraints</p> <p><i>Applicability depends on systemic feasibility: time, infrastructure, collaboration culture, governance coherence. Suggestions to align implementation with existing reform agendas, address infrastructure inequalities explicitly and promote interdisciplinary collaboration structures.</i></p>	✓	✓	✓	✓	✓
3	<p>Governance, Policy & Assessment Alignment</p> <p><i>Sustainable applicability depends on alignment with curriculum reforms, policy structures, and assessment systems. Suggestions to map framework to national curricula and reform priorities, provide assessment alignment examples and recommend governance anchoring mechanisms.</i></p>	(✓)	(✓)	✓	✓	✓

4	<p>Phased / Pilot-Based Implementation</p> <p><i>Immediate system-wide rollout is considered unrealistic. Gradual implementation through pilots, staged scaling, and contextual adaptation is preferred. Suggestions to recommend pilot schools before national rollout, develop phased implementation roadmap (short-, mid-, long-term) and include monitoring and refinement mechanisms.</i></p>	✓	✓	(✓)	✓	✓
5	<p>Teacher Capacity as Bottleneck</p> <p><i>The main limitation is not student ability but teacher readiness, especially for advanced domains like Modelling & Automation. Suggestions to prioritize teacher preparation in implementation strategy, define competence expectations for educators explicitly and differentiate PD support for generalist vs specialist teachers.</i></p>	✓	✓	(✓)	(✓)	✓
6	<p>Practice-Oriented Professional Development</p> <p><i>Professional learning must be experiential and classroom-oriented, not purely theoretical. Suggestions to design PD programs based on classroom cases and task design, include assessment alignment and analysis of student artifacts and provide ready-to-use tools (rubrics, scenarios, guides).</i></p>	✓	(✓)	(✓)	✓	✓
7	<p>Feasible Entry Points & Domain Differentiation</p> <p><i>Some domains are immediately implementable (Questioning, basic analysis), while others require stronger support and infrastructure. Suggestions to identify “low-threshold” entry domains explicitly, provide staged emphasis guidance and signal infrastructure-dependent domains clearly.</i></p>	✓	(✓)	-	✓	✓
8	<p>Simplification / Reduced Complexity</p> <p><i>The Framework is perceived as academically sound but overly complex for everyday classroom use. Suggestions to streamline descriptors and reduce redundancy, provide condensed practitioner-friendly versions and improve visual clarity and compact representation.</i></p>	-	✓	-	✓	(✓)

Recommendations

Each national report contains a list of recommendations resulting from the qualitative analysis of transcripts generated from discussions during validation workshops involving policy experts, stakeholders, and teachers in Greece, Cyprus, Poland, Portugal, and Germany.

The table below presents a complete raw cross-national matrix of all **67 recommendations** exactly as they are shown in the national reports, with no consolidation, no merging, and no similarity grouping, serving as an overview of the analysis outcomes and as a preparatory step for the actionable synthesis of the results.

Ref	Recommendations	GR	DE	PL	PT	CY
GR-1	Reduce domain ambiguity through explicit consolidation or hierarchy	☑	☐	☐	☐	☐
GR-2	Reposition Awareness, Ethics & Agency as a transversal layer	☑	☐	☐	☐	☐
GR-3	Make non-linearity explicit in the framework logic	☑	☐	☐	☐	☐
GR-4	Redefine progression bands as flexible pedagogical zones	☑	☐	☐	☐	☐
GR-5	Introducing a preschool / early years entry point	☑	☐	☐	☐	☐
GR-6	Restructure proficiency levels to be observable and domain-specific	☑	☐	☐	☐	☐
GR-7	Clarify core vs. advanced domains	☑	☐	☐	☐	☐
GR-8	Strengthening conceptual grounding and terminology	☑	☐	☐	☐	☐
GR-9	Explicitly integrate AI and big data as cross-cutting concerns	☑	☐	☐	☐	☐
GR-10	Define low-threshold classroom entry points	☑	☐	☐	☐	☐
GR-11	Anchor progression and proficiency through concrete scenarios	☑	☐	☐	☐	☐
GR-12	Embed equity considerations directly into implementation guidance	☑	☐	☐	☐	☐
GR-13	Clarify what “successful use” of the framework looks like	☑	☐	☐	☐	☐
GR-14	Design the framework explicitly as a toolkit, not a checklist	☑	☐	☐	☐	☐

Ref	Recommendations	GR	DE	PL	PT	CY
GR-15	Prepare the framework for phased and pilot-based rollout	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-1	Clarify and broaden the concept of “data”	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-2	Integrate the societal role and impact of data	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-3	Review progression in relation to learners’ cognitive development and structural requirements	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-4	Highlight connections to national curricula and cross-curricular frameworks	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-5	Distinguish between core and advanced domains and introduce subject-specific allocation	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-6	Reduce overlaps between domains	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-7	Clarify the concepts of ethics and fairness and strengthen the ethical dimension	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-8	Include creative forms of data visualization	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-9	Moving beyond a data protection perspective	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-10	Review transitions between progression levels and learning objectives	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-11	Differentiate between “learning with data” and “learning from data”	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-12	Acknowledge the transition from primary to secondary education in Germany	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-13	Incorporate upper secondary education into the framework	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-14	Provide lesson examples for non-STEM subjects	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-15	Rethink the examples used	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-16	Review of the use of abbreviations	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
DE-17	Reducing complexity and streamlining the framework	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PL-1	Strengthen Conceptual Clarification and Positioning	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PL-2	Increase Visibility of Practical Implementation Pathways	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PL-3	Clarify Core vs. Advanced Competences	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PL-4	Provide Guidance on System-Level Implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PL-5	Emphasize Civic and Societal Relevance	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PL-6	Avoid Perception as Additional Curriculum Burden	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
PT-1	Language and descriptors	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
PT-2	Structure and representation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
PT-3	Balance between domains and clarification of boundaries	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
PT-4	Link to the curriculum and support materials	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
PT-5	Operationalization of ethics and equity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
PT-6	Implementation and sustainability	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
CY-1	Explicit Articulation of the Transversal Role of Awareness, Ethics & Agency	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-2	Enhancement of Navigability and Reduction of Cognitive Load	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-3	Improved Vertical Readability of Learning Expectations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-4	Indicative Alignment Between Bands, Levels, and Grades	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-5	Strengthening the Epistemological Dimension	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-6	Reinforcement of Data Quality within Data Acquisition & Management	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-7	Clarification of Domain Boundaries	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-8	Clarification of the Role of Digital Tools	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-9	Developmentally Sensitive Positioning of Modelling & Automation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-10	Reframing Proficiency Levels as Developmental Scaffolds	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-11	Introducing a preschool / early years entry point	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-12	Integration of Observable Performance Indicators	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-13	Explicit Recognition of Non-Linearity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-14	Development of a Practical Implementation Toolkit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-15	Provision of Low-Threshold Entry Strategies	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-16	Assessment Integration Guidance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-17	Operationalization of Ethical Safeguards	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-18	Strengthening Civic Orientation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-19	Explicit Integration of Equity Principles	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-20	Formal Curriculum Integration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-21	Pilot-Based Validation Prior to Scaling	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-22	Sustained Professional Development Model	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
CY-23	Prevention of Technocratic Adoption	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>

As a next step, we conducted a thematic group analysis of similar recommendations which could guide revisions to framework especially in core dimensions such as domains, bands and levels. In the table below, we present the main outcomes, which will serve as a **roadmap** for an internal consultation between the partners to make all the needed adaptations to the framework and establish the **1st working draft**, which will guide the next phase of the project, e.g. the development of the learning scenarios, the HE courses, the TPD programs and the school pilots.

1. Conceptual-specific recommendations

- GR-8 Strengthen conceptual grounding and terminology
- DE-1 Clarify and broaden the concept of “data”
- DE-9 Moving beyond a data protection perspective
- DE-11 Differentiate between “learning with data” and “learning from data”
- PL-1 Strengthen Conceptual Clarification and Positioning
- CY-5 Strengthening the Epistemological Dimension
- CY-13 Explicit Recognition of Non-Linearity

2. Domain-specific recommendations

- GR-1 Reduce domain ambiguity through explicit consolidation or hierarchy
- GR-3 Make non-linearity explicit in the framework logic
- GR-7 Clarify core vs. advanced domains
- GR-10 Define low-threshold classroom entry points
- DE-6 Reduce overlaps between domains
- DE-5 Distinguish between core and advanced domains and introduce subject-specific allocation
- PL-3 Clarify Core vs. Advanced Competences
- PL-6 Avoid Perception as Additional Curriculum Burden
- PT-2 Structure and representation
- PT-3 Balance between domains and clarification of boundaries
- CY-6 Reinforcement of Data Quality within Data Acquisition & Management
- CY-7 Clarification of Domain Boundaries
- CY-9 Developmentally Sensitive Positioning of Modelling & Automation
- CY-15 Provision of Low-Threshold Entry Strategies

3. Progression-specific recommendations

- GR-4 Redefine progression bands as flexible pedagogical zones
- GR-6 Restructure proficiency levels to be observable and domain-specific
- GR-11 Anchor progression and proficiency through concrete scenarios
- DE-3 Review progression in relation to learners’ cognitive development and structural requirements
- DE-10 Review transitions between progression levels and learning objectives
- DE-12 Acknowledge the transition from primary to secondary education in Germany
- CY-4. Indicative Alignment Between Bands, Levels, and Grades
- CY-10 Reframing Proficiency Levels as Developmental Scaffolds
- CY-12 Integration of Observable Performance Indicators

4. Ethics-specific recommendations

- GR-2 Reposition Awareness, Ethics & Agency as a transversal layer
- DE-7 Clarify the concepts of ethics and fairness and strengthen the ethical dimension
- PT-5 Operationalization of ethics and equity
- CY-1 Explicit Articulation of the Transversal Role of Awareness, Ethics & Agency
- CY-17 Operationalization of Ethical Safeguards

5. Education-specific recommendations

- GR-5 Introduce a preschool / early years entry point
- DE-13 Incorporate upper secondary education into the framework
- CY-11 Introduce a preschool / early years entry point

6. Readability-specific recommendations

- GR-14 Design the framework explicitly as a toolkit, not a checklist
- DE-16 Review the use of abbreviations
- DE-17 Reducing complexity and streamlining the framework
- PT-1 Language and Descriptors
- CY-2 Enhancement of Navigability and Reduction of Cognitive Load

7. Expansion-specific recommendations

- GR-9 Explicitly integrate AI and big data as cross-cutting concerns
- DE-2 Integrate the societal role and impact of data
- CY-8 Clarification of the Role of Digital Tools
- CY-19 Explicit Integration of Equity Principles

7. Applicability-specific recommendations

- GR-13 Clarify what “successful use” of the framework looks like
- GR-12 Embed equity considerations directly into implementation guidance
- GR-15 Prepare the framework for phased and pilot-based rollout
- DE-4 Highlight connections to national curricula and cross-curricular frameworks
- DE-8 Include creative forms of data visualization
- DE-14 Provide lesson examples for non-STEM subjects
- DE-15 Rethink the examples used
- PL-2 Increase Visibility of Practical Implementation Pathways
- PL-4 Provide Guidance on System-Level Implementation
- PL-5 Emphasize Civic and Societal Relevance
- PT-4 Link to the curriculum and support materials
- CY-3 Improved Vertical Readability of Learning Expectations
- CY-14 Development of a Practical Implementation Toolkit
- CY-16 Assessment Integration Guidance
- CY-20 Formal Curriculum Integration

7. Sustainability-specific recommendations

- GR-6 Implementation and sustainability
- CY-18 Strengthening Civic Orientation
- CY-21 Pilot-Based Validation Prior to Scaling
- CY-22 Sustained Professional Development Model
- CY-18 Prevention of Technocratic Adoption



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Annex

Invitation to Participate in Consultation Workshop Validation of the Data Literacy Skills Framework in Education



Invitation to Participate in Consultation Workshop Validation of the Data Literacy Skills Framework in Education

Project Title: DATA-READY – Empowering Education through Data Literacy Integration in Compulsory Education

Reference Number: 101195801

Implementation Period: 01/03/2025 – 29/02/2028

Dear **[Name]**,

On behalf of the Erasmus+ KA3 project **DATA-READY**, we are pleased to invite you to participate in a **Consultation Workshop** dedicated to the validation of the project's **Data Literacy Skills Framework for Compulsory Education**.

About the DATA-READY Project

The DATA-READY project aims to enhance data literacy skills among students in compulsory education (primary and secondary levels) across Europe. To achieve this objective, the project is developing a standardized and structured framework for data literacy education, which will serve as a reference for teachers and policymakers. A consortium of partners from Greece, Portugal, Germany, Poland, and Cyprus implements the project.

Purpose of the Workshop

The Consultation Workshop represents a key stage in the framework validation process, aiming to ensure its quality, relevance, feasibility, and adaptability across diverse educational systems and contexts. The workshop is addressed to policymakers, representatives of educational authorities, academics, and experts in the field of education.

As a participant, you will be invited to:

- Review and assess the structure, content, and applicability of the Data Literacy Skills Framework
- Provide expert feedback based on your professional experience
- Contribute recommendations for the framework's refinement and enhancement

Workshop Details

Date: .. January 2026

Location: ..., ...

Address:

Mode: Face-to-face or online (hybrid)

Your expertise and perspective will be invaluable in shaping a practical, impactful, and policy-relevant framework for data literacy education in Europe.

Please confirm your participation by replying to this email.

Kind regards,

[Your Name]

[Contact Information]



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Consent Form for Workshop Participation



Erasmus+



Project Title: **DATA-READY**

Reference Number: **101195801**

Implementation period: **01/03/2025 – 29/02/2028**

DATA READY

Consent Form for Workshop Participation

We invite you to collaborate with the project “Empowering Education through Data Literacy Integration in Compulsory Education (DATA-READY)” an Erasmus+ European Policy Experimentation (ERASMUS-EDU-2024-POL-EXP) Program. The DATA-READY project aims to develop, implement, and test a new policy approach to enhancing Data Literacy skills of students in compulsory education (primary and early secondary).

The purpose of this workshop is to collect feedback on the framework’s structure, content, and applicability in your national context. The workshop’s discussion will be audio recorded, and the subsequent interview transcriptions will be made fully anonymous.

All names and identifiers will be removed to ensure full anonymity. As this is a Europe-wide consultation, the transcripts will be translated into the English language. All data collected will be treated and analyzed by each national team and shared among project partners for analysis. The findings from the focus group will be analyzed, published and made publicly available. The project report will not contain any personal identifiable information.

The data gathered through the workshops will be strictly used explicitly for this project. The responses will be handled in a discreet manner, and responses are completely anonymous. The answers will be saved in a properly secured place, with no authorization from anyone apart from the Research Team. Our consortium complies with the GDPR regulation and the protection and processing of personal data.

Your participation is not mandatory, and refusal will not harm your relationship with the project team or institution. At any time, you may withdraw from participating in this focus group and withdraw your consent.

By signing this informed consent, participants agree to maintain the confidentiality of the information discussed by all participants and researchers during the focus group session. The exercise of the rights to information, access, rectification, erasure, portability and limitation of treatment should be done with the local organization responsible for the project development in [country, organization, address, ...].

Thank you for your collaboration

I _____, have been informed of the objectives of the consultation for the DATA-READY project in a clear and detailed manner. I have had the opportunity to ask questions, and my questions have been answered. I understand that at any time I may request new information and change my decision to participate if I wish. I give consent to the audio recordings of the focus group and to having my anonymised transcribed interview data. I agree to maintain confidentiality of the information discussed by all participants and researchers during the focus group session

Date: __/__/2025

Participant’s name and signature: _____



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