Teacher training for Data Literacy & Computer Science competences

D1.1 - Policy Research Summary and D5.1 - Research of policies/curricula

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1. Executive summary

This report is the first in a series of project deliverables aiming to develop a policy monitor related to digital education, with a focus on evaluating the state of data literacy and AI education (including teacher education in this context). The focus of this report is on the collection of requirements for the policy monitor, and provides recommendations for the development and reporting of the policy monitor in subsequent deliverables. While the intention is to extend the policy monitor on a global level in the long-term, the aim of this project is to develop the policy monitor framework and evaluate policies and curricula in a selected set of case studies, focusing on the European Union, Germany, Austria and Lithuania.

The research was done in parallel with the research for deliverable D5.1 – the investigation of existing policies and curricula regarding DL&AI education and teacher training recommendations. Our analyses revealed that the focus areas of deliverable D1.1 and deliverable D5.1 are strongly interrelated. In favour of a coherent structure and a comprehensible and consistent results, it was decided to integrate the findings of D1.1 and D5.1 into one unified deliverable report. Therefore this report also covers the results and findings of deliverable D5.1.

Section 2 elaborates on the goals for the policy monitor developed in this project and details the scientific methodology taken to collect information to be able to assess policy monitor requirements, which is based on collaborative stakeholder workshops and desk research. Furthermore, it highlights the similarities and difference of related policy monitor initiatives provided by the European Union, the OECD and UNESCO. While those related initiatives provide valuable insight into different aspects of digital education on a European and global level, none of them allow to gain the insight that the policy monitor proposed for this project aims for: The state of implementation relating to data literacy and AI education, as well as the state of teacher education in this context.

Section 3 sets the context for data literacy and AI education by assessing and defining content requirements, serving as a basis for evaluating if and to which level education policies implement those requirements. This definition is based on previous work, which for data literacy is based on the quasi-standard definitions provided by the EU digital competence framework (DigComp)[1] and encompasses: **(1)** Browsing, searching and filtering data, information and digital content, **(2)** Evaluating data, information and digital content, **(3)** Managing data, information and digital content. For AI education, a widely recognized definition at the level of DigComp does not yet exist. Our definition is based on research done in the context of this project and reported in of WP2, defining the requirements of AI education according to the "Dagstuhl-Dreieck"[2] and encompasses: ": **(1)** Technical aspects of AI, **(2)** Social and cultural aspects of AI, **(3)** Application related aspects of AI.

Section 4 discusses the core policy documents that have been identified through stakeholder workshops and desk research for the initial case studies including EU, Germany, Austria and Lithuania. Besides a general overview, the relevance of the policies relating to data literacy, AI and teacher education are specifically discussed.

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[1] https://publications.jrc.ec.europa.eu/repository/handle/JRC106281
[2] https://dagstuhl.gi.de/dagstuhl-erklaerung

Section 5 provides an overview table summarising the policy documents identified during this initial analysis. Section 6 discusses the main conclusions drawn from this initial analysis, and provides recommendations for the policy monitor to be developed and reported in subsequent deliverables. Those conclusions and recommendations include:

1. The policy documents that need to be considered in the education context are quite divers and range from high level strategies to concrete curricula implementations.
2. The target audience for this diverse set of policy documents is broad, which needs to be considered by the policy monitor.
3. The approach to policy implementation differs between member states and may be national or regional responsibility. This needs to be considered by the policy monitor.
4. Content indicators for data literacy and AI derived for the compare system of the policy monitor should be based on the DigComp and "Dagstuhl-Dreieck" definitions outlined above.
5. The nature of the diverse policy documents necessitates a valuation of indicators in the compare system that is more complex than true/false valuation.
6. Besides content indicators, the policy monitor should assess whether other aspects related to teacher education – specifically pedagogical and didactical competences - are covered by a policy document.

2. Context and related initiatives

The context and aim of this and subsequent policy monitor deliverables is to assess the state of educational policies in the context of data literacy and AI across Europe, including the state of teacher education in this context. The scientific methodology used is to conduct a series of stakeholder workshops to collaboratively identify the policy environment in Europe (in the initial stage of the project with focus on the project countries Austria, Germany and Lithuania), followed by further desk research to substantiate the results and derive a suitable policy monitor framework. At the time of writing for this report, a first round of workshops has been conducted with stakeholders in the member states most relevant for this project: Germany, Austria and Lithuania. The goal of those first national workshops was to bring together stakeholders such as policy- and decision-makers as well as experts in the field of education in order to present the project to them, to gather insights and feedback as well as to discuss ideas and suggestions, including details relating to the policy environment they operate in. In the following Sections the results of those initial workshops relating to the establishment of a policy monitor are processed, and conclusions as well as recommendations for establishing a policy monitor in subsequent deliverables are given.

Previous work on policy monitors related to education in the context of digital skills, AI and even teacher education have been identified. Three relevant policy monitors by the European Commission, the OECD and the UNESCO are especially relevant to this project and are discussed below, highlighting their context and aim, as well as the difference to the policy monitor proposed in this project.

The Digital Education Policies in Europe and Beyond report[3] published by the European Commission in 2017 provides an excellent overview on digital education policies in Europe and selected countries outside the EU, focusing on highlighting key enablers, success factors and barriers, aimed at guiding policy makers at local, regional, national and international levels. The report is based on more than 40 policy initiatives on national and regional level, and it studies 6 of them in depth (Estonia, Ireland, Poland, Australia, Canada and Malaysia). While this report provides an excellent and in-depth study of policy initiatives, its focus is mainly on understanding the use of digital technologies in teaching and the establishment of teaching capacities (mainly in the context of enhancing teacher's skills in using the digital teaching technologies). It does not focus on evaluating content aspects (like data literacy and AI), nor does it consider the teacher education policy aspect.

The OECD AI policy observatory[4] provides a multi-disciplinary repository and visualisation of global policies on AI. Policies are presented in a multitude of policy areas, including education. Policies can be listed on a national level; however the monitor does not provide possibilities to filter policies according to content aspects (like data literacy and AI), or according to their relevance for teacher education. Furthermore, it has been observed that key policy documents related to education were missing compared to the analysis this project has done, especially when looking at regional AI education policies in countries where education is managed on regional level (like Germany). A very similar visualisation of national AI initiatives is provided by the Council of Europe[5], but without the ability to filter the initiatives by their applicability to education.

The UNESCO has published A Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2[6], with Indicator 4.4.2 showing the percentage of youth/adults who have achieved at least a minimum level of proficiency in digital literacy skills. This framework builds on the digital literacy skills defined by the EU DigComp framework (which will be discussed in detail in Section 4.1), and provides data on digital literacy based on empirical studies assessing existing data literacy frameworks in 47 countries. Based on those findings, a recommendation for a global data literacy framework is provided by the report. The report provides an excellent overview of digital competence frameworks used in a wide variety of countries on a global level. The results show predominantly that enterprise frameworks are adopted, with the dominant framework being the International Certification of Digital Literacy (ICDL)[7] adopted in 31 countries and the Certiport Internet and Computing Core Certification (IC3)[8] adopted in 13 countries. In contrast to the policy monitor developed in this project, the UNESCO report does not focus on digital literacy education in schools (the relevance for national education policies remains unclear in many cases), and it does not consider teacher education in this context.

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3 Conrads, J., Rasmussen, M., Winters, N., Geniet, A., & Langer, L. (2017). Digital Education Policies in Europe and Beyond. Luxembourg: European Commission Joint Research Centre.

4 https://oecd.ai/en/

5 https://www.coe.int/en/web/artificial-intelligence/national-initiatives

6 UNESCO. (2018). A Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2. Montreal: UNESCO Institute for Statistics.

7 https://icdl.org/

8 https://certiport.pearsonvue.com/Certifications/IC3/Digital-Literacy-Certification/Overview

3. Definition of data literacy and AI in the education context

Before discussing policy documents in Section 4 of this document, this Section will define the terminology for data literacy and AI to be used by the policy monitor developed in this project, as a basis to assess the relevance of individual policy documents to the education context of this project.

3.1 Data literacy

The de-facto standard definition of data literacy in education is provided by the EU DigComp framework[9] (version 2.1 at the time of writing), which defines as one of its 5 competence areas the "**Competence area 1: Information and data literacy**". Information and data literacy is defined by core competences in:

- Browsing, searching, filtering data, information and digital content
- Evaluating data, information and digital content
- Managing data, information and digital content

The learning outcome for each core competence is defined on 8 proficiency levels by the DigComp, as cited in the following tables:

Browsing, searching, filtering data, information and digital content (Source: DigComp 2.1)		
Foundation	Proficiency level 1	At basic level and with guidance, I can: 1 identify my information needs, 2 find data, information and content through a simple search in digital environments, 3 find how to access these data, information and content and navigate between them. 4 identify simple personal search strategies.
	Proficiency level 2	At basic level and with autonomy and appropriate guidance where needed, I can: 1 identify my information needs, 2 find data, information and content through a simple search in digital environments, 3 find how to access these data, information and content and navigate between them. 4 identify simple personal search strategies.
Intermediate	Proficiency level 3	On my own and solving straightforward problems, I can: 1 explain my information needs, 2 perform well-defined and routine searches to find data, information and content in digital environments, 3 explain how to access them and navigate between them.

9 https://publications.jrc.ec.europa.eu/repository/handle/JRC106281

Advanced		4 explain well-defined and routine personal search strategies.
	Proficiency level 4	**Independently, according to my own needs, and solving well-defined and non-routine problems, I can:** 1 illustrate information needs, 2 organise the searches of data, information and content in digital environments, 3 describe how to access to these data, information and content, and navigate between them. 4 organise personal search strategies.
	Proficiency level 5	**As well as guiding others, I can:** 1 respond to information needs, 2 apply searches to obtain data, information and content in digital environments, 3 show how to access to these data, information and content and navigate between them. 4 propose personal search strategies.
	Proficiency level 6	**At advanced level, according to my own needs and those of others, and in complex contexts, I can:** 1 assess information needs, 2 adapt my searching strategy to find the most appropriate data, information and content in digital environments, 3 explain how to access to these most appropriate data, information and content and navigate among them. 4 vary personal search strategies.
Highly Specialised	**Proficiency level 7**	**At highly specialised level, I can:** 1 create solutions to complex problems with limited definition that are related to browsing, searching and filtering of data, information and digital content. 2 integrate my knowledge to contribute to professional practice and knowledge and guide others in browsing, searching and filtering data, information and digital content.
	Proficiency level 8	**At the most advanced and specialised level, I can:** 1 create solutions to solve complex problems with many interacting factors that are related to browsing, searching and filtering data, information and digital content. 2 propose new ideas and processes to the field.

Evaluating data, information and digital content (Source: DigComp 2.1)

Foundation	Proficiency level 1	At basic level and with guidance, I can: 1 detect the credibility and reliability of common sources of data, information and their digital content.
	Proficiency level 2	At basic level and with autonomy and appropriate guidance where needed, I can: 2 detect the credibility and reliability of common sources of data, information and their digital content
Intermediate	Proficiency level 3	On my own and solving straightforward problems, I can: **3 perform the analysis, comparison and evaluation of the credibility and reliability of well-defined sources of data, information and digital content.** 4 perform the analysis, interpretation and evaluation of well-defined data, information and digital content
	Proficiency level 4	Independently, according to my own needs, and solving well-defined and non-routine problems, I can: 1 perform the analysis, comparison and evaluation of sources of data, information and digital content. 2 perform the analysis, interpretation and evaluation of data, information and digital content.
Advanced	Proficiency level 5	As well as guiding others, I can: 1 carry out an evaluation of the credibility and reliability of different sources of data, information and digital content. 2 carry out an evaluation of different data, information and digital content.
	Proficiency level 6	At advanced level, according to my own needs and those of others, and in complex contexts, I can: 1 critically assess the credibility and reliability of sources of data, information and digital content. 2 critically assess data, information and digital content.
Highly Specialised	Proficiency level 7	At highly specialised level, I can: 1 create solutions to complex problems with limited definition that are related to analysing and evaluating credible and reliable sources of data, information and content in digital environments.

| | | 2 integrate my knowledge to contribute to professional practices and knowledge and to guide others in the analysis and evaluation of the credibility and reliability of data, information and digital content and their sources. |
| | Proficiency level 8 | At the most advanced and specialised level, I can:
1 create solutions to solve complex problems with many interacting factors that are related to analysing and evaluating credible and reliable sources of data, information and content in digital environments.
2 propose new ideas and processes to the field. |

Managing data, information and digital content (Source: DigComp 2.1)		
Foundation	Proficiency level 1	At basic level and with guidance, I can: 1 identify how to organise, store and retrieve data, information and content in a simple way in digital environments. 2 recognise where to organise them in a simple way in a structured environment.
	Proficiency level 2	At basic level and with autonomy and appropriate guidance where needed, I can: 1 identify how to organise, store and retrieve data, information and content in a simple way in digital environments. 2 recognise where to organise them in a simple way in a structured environment.
Intermediate	Proficiency level 3	On my own and solving straightforward problems, I can: 1 select data, information and content in order to organise, store and retrieve in a routine way in digital environments. 2 organise them in a routine way in a structured environment.
	Proficiency level 4	Independently, according to my own needs, and solving well-defined and non-routine problems, I can: 1 organise information, data and content to be easily stored and retrieved. 2 organise information, data and content in a structured environment.
Advanced	Proficiency level 5	As well as guiding others, I can: 1 manipulate information, data and content for their easier organisation, storage and retrieval. 2 carry out their organisation and processing in a structured environment.

	Proficiency level 6	**At advanced level, according to my own needs and those of others, and in complex contexts, I can:** 1 adapt the management of information, data and content for the most appropriate easy retrieval and storage. 2 adapt them to be organised and processed in the most appropriate structured environment.
Highly Specialised	Proficiency level 7	**At highly specialised level, I can:** 1 create solutions to complex problems with limited definition that are related to managing data, information, and content for their organisation, storage and retrieval in a structured digital environment. 2 integrate my knowledge to contribute to professional practices and knowledge and to guide others in managing data, information and digital content in a structured digital environment.
	Proficiency level 8	**At the most advanced and specialised level, I can:** 1 create solutions to solve complex problems with many interacting factors that are related to managing data, information, and content for their organisation, storage and retrieval in a structured digital environment. 2 propose new ideas and processes to the field.

3.2 Artificial intelligence

Compared to data literacy, the concepts of AI in education are less well defined or universally recognised. This project will rely on an initial effort by project partners to capture the core aspects relevant for AI education, which adapts the "Dagstuhl-Dreieck" for defining the core aspects of the "Digital Networked World" to AI education. Initial results in this context are reported in more detail in WP2, with relevant parts summarised in this Section. Figure 1 represents an adaptation to the AI context of the "Dagstuhl-Dreieck" for digital education, in which AI education is categorised by three core aspects, the technical perspective, the societal and cultural perspective, and the application perspective.
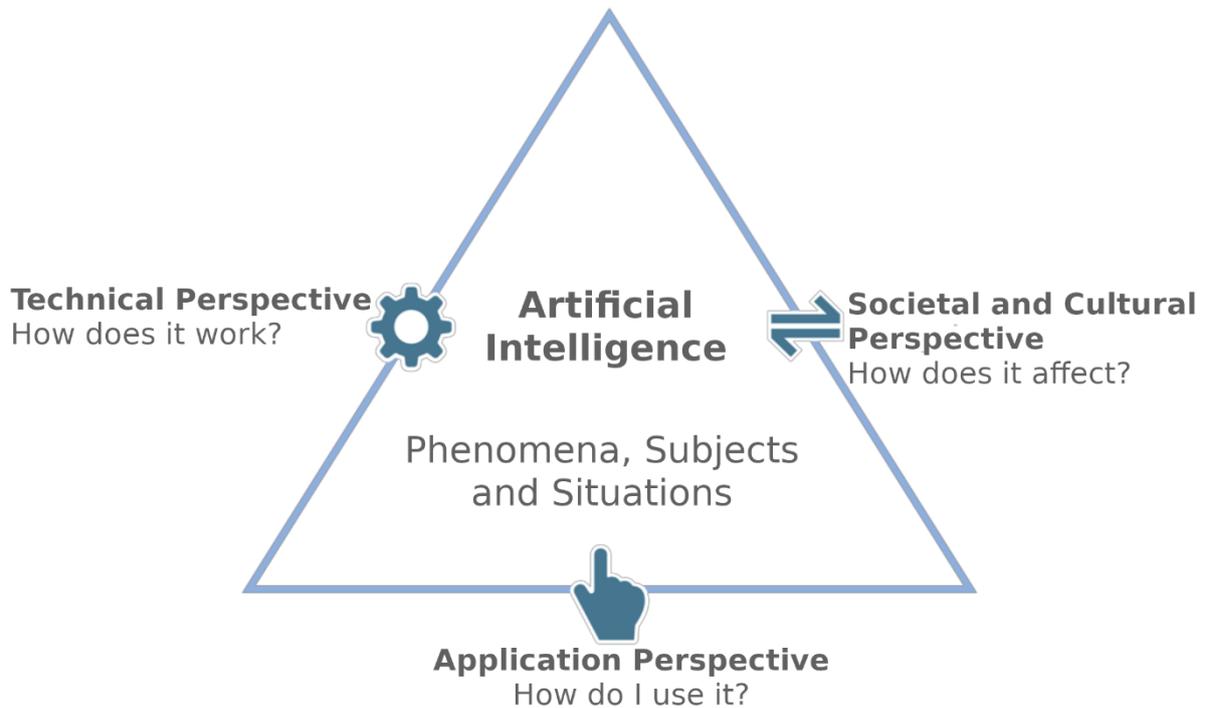
Figure 1: Dagstuhl-Dreieck for AI education

Following specific areas have been identified in each of the core areas:

Artificial Intelligence education	
Technical perspective	Identification of AI systems
	Definition of AI
	Strong/Weak AI
	Characterise subfields and application areas of AI
	AI approaches
	Machine learning approaches
	Reinforcement learning, supervised learning, unsupervised learning
	Machine learning implementation methods
	Correlation and causality
	Transparency and explainability
	Data selection and processing
	Classic/Symbolic AI approaches
	Knowledge representation
	Knowledge processing
	Perception, sensing
	Use of AI instead of classic algorithms (uncertainty)
Societal and cultural perspective	AI in society
	Natural and artificial intelligence
	History and milestones of AI
	Bias
	Security and reliability of AI

	Impacts, chances and challenges of AI
	Human responsibility in AI usage
	Limitations of AI
Application perspective	Error-proneness of AI
	Use-case specific selection of AI methods
	Application of AI to specific data driven problems

4. Initial policy overview

This Section provides an overview and summarises core policy documents on EU level as well as on the level of selected member states relevant to this project (Germany, Austria, Lithuania). This is based on the outcomes of the project's initial stakeholder workshops, as well as additional desk research.

4.1. European Union policies

As the world is more and more reliant on digital services, it is more important than ever that people have sufficient knowledge about the most common digital applications – so called Digital Competence. In 2013, the European Union released the first version of the *European Digital Competence Framework*, which is often just called **DigComp**[10]. This document can be used as a framework or a tool to guide the improvement of the digital competence of each countries' citizens. As of today, the most recent version of the DigComp Framework is version 2.1 but version 2.2 is already in revision and will probably be published in early 2022. DigComp 2.0 describes a list of five competence areas and 21 competences to which the DigComp 2.1 adds eight proficiency levels:

Information and data literacy	Browsing, searching and filtering data, information and digital content
	Evaluating data, information and digital content
	Managing data, information and digital content
Communication and collaboration	Interacting through digital technologies
	Sharing through digital technologies
	Engaging in citizenship through digital technologies
	Collaborating through digital technologies
	Netiquette
	Managing digital identity
Digital content creation	Developing digital content
	Integrating and re-elaborating digital content
	Copyright and licences
	Programming
Safety	Protecting devices
	Protecting personal data and privacy
	Protecting health and well-being

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10 https://publications.jrc.ec.europa.eu/repository/handle/JRC106281

	Protecting the environment
Problem solving	Solving technical problems
	Identifying needs and technological responses
	Creatively using digital technologies
	Identifying digital competence gaps

While the digital competence of citizen's is one thing, another important factor is the digital competence of teachers and other teaching personnel. In addition to the general digital competences needed in life and work, they need to have specific competences regarding the use of digital technologies for teaching. Therefore, also in 2013, the European Union published the *European Framework for the Digital Competence of Educators*, often referred to as **DigCompEdu**[11]. In comparison to the DigComp, the DigCompEdu includes six different areas with a total of 22 competences defining the recommended digital skills for teachers:

Professional engagement	Organisational communication
	Professional collaboration
	Reflective practice
	Digital Continuous Professional Development
Digital Resources	Selecting digital resources
	Creating and modifying digital resources
	Managing, protecting and sharing digital res.
Teaching and Learning	Teaching
	Guidance
	Collaborative learning
	Self-regulated learning
Assessment	Assessment strategies
	Analysing evidence
	Feedback and planning
Empowering Learners	Accessibility and inclusion
	Differentiation and personalisation
	Actively engaging learners
Facilitating Learners' Digital Competence	Information and media literacy
	Digital communication and collaboration
	Digital content creation
	Responsible use
	Digital problem solving

As this report focuses on the policies regarding Data Literacy and Artificial Intelligence, the following paragraphs will discuss the frame in which the European Union defines policies for these specific topics. In contrast to the country-specific

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11 https://publications.jrc.ec.europa.eu/repository/handle/JRC107466

policies, the DigComp(Edu), is not mandatory for European countries. Rather it is recommended to be used as a framework to build each countries' policies for the points raised and self-assessments for students and educators to check their digital skill level.

4.1.1 Policies for Data Literacy

Data Literacy is a big topic in the digitalisation of our society, therefore it is one of the five competence areas of the **DigComp,** as has been outlined already on Section 3.1. It is defined as the act of reading, writing, and communicating of information and data in the appropriate context. Additionally, the understanding und analysis of sources and methodical approaches to find the correct information is also an important factor. The DigComp splits this topic into three core competence areas, which will be elaborated in the following paragraphs and will then be compared to the DigCompEdu.

4.1.2 Policies for AI

In the *Digital Education Action Plan*[12] for 2021-2027, the EU takes notice to the rapid change in digital communication and usage. In point six of the actions of strategic priority 1, it is mentioned, that it is planned to "promote understanding of emerging technologies and their applications in education" and to "develop ethical guidelines on artificial intelligence (AI) and data usage in teaching and learning for educators". In addition, researchers and students will be part of a training programme on the ethical usage of AI. Also, in point 8, an update to the DigComp is planned to include AI and data-related skills. Furthermore, the development of AI learning resources for different education levels and the general awareness of AI in education is mentioned.

4.1.3 Policies for Educators

The **DigCompEdu** defines similar points to the ones in the DigComp. More so, it focuses on Digital Resources in general, as educators already have a wide variety of digital resources already and therefore need to effectively use that. Regarding to the DigCompEdu, it is a key competence, to "identify, assess and select digital resources for teaching and learning". They must consider different target groups and choose pedagogical approaches that fit the specific learning objective.
In comparison to the DigComp, not only the use of already existing content is defined in the DigCompEdu. Furthermore, *Creating and modifying digital resources* is also important. Educators should be able to use openly licensed resources considering the mentioned context and (co-)create new resources.
In addition to the creation, *Managing, protecting and sharing digital resources*, describes the organisation of digital content and the ability to "make it available to learners, parents and other educators". With the access of others, it is also vital to effectively protect sensitive digital content, comply to privacy rules and copyrights and use open licenses accordingly.

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12 https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en

4.2 German policies

In Germany, the creation of policies for curricula is based on the control of each federal state. Besides that, the German government released several strategies as recommendation for the development of digitalization. The first one is called *Shaping Digitalization*[13] and depicts a strategy for the digital change. It includes aspects of digital competences, infrastructure and equipment, innovation and digital transformation, society, and digital change and of the modernisation of the country. Another document is the **Datastrategy**[14] *of the federal government*. The main goal of the strategy is, to support informed and independent digital behaviour of citizens of all ages. Furthermore, they want to strengthen data literacy and collect current nationwide conditions to accordingly provide support where needed. The **AI strategy of the German federal government**[15] does not cover education aspects of AI.

The initiative **Education in the Digital World**[16] is an initiative by the Standing Conference of the Ministers of Education and Cultural Affairs (KMK) and was started by chancellor Dr. Angela Merkel and minister of education Anja Karliczek. Its goal is to combine to support the development of digital competences of students through their whole education. They want to achieve this by building the required infrastructure and aiding for the development of digital learning-tools. Additionally, they care for qualified education personnel and up to date content and methods.

None of these plans are binding though. Each federal state can decide how and if they integrate some of the strategies or get help building their infrastructure for digital competence. Therefore, the following paragraphs will be split for each state of Germany. As of now, this report contains the data of five states: Baden-Württemberg, Berlin, Brandenburg, Nordrhein-Westfalen, and Schleswig-Holstein.

Baden-Württemberg	In general Baden-Württemberg has developed a curriculum where every kind of school does have an independent course of computer science in the 7th grade. In "Hauptschulen/Werkrealschulen" and "Realschulen" students have the possibility to choose computer science as an optional subject during 8th, 9th and 10th grade. Other kinds of schools like "Gemeinschaftsschule" and "Gymnasium" do have some part of interdisciplinary course of computer science, also in 8th, 9th and 10th grade[17].
Berlin	Berlin developed a curriculum in which the "Gemeinschaftsschule", "Integrierte Sekundarschule" and the "Gymnasium" do all have a basic information-technological course in 7th grade and computer science as an independent class all through 7th to 10th grade[18]. The "Gymnasiale Oberstufe" does continue this class until the last grade of school. Also, it is planned to adopt the KMK strategy *Education in the digital world* it is planned to build a binding competence

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13 https://www.bundesregierung.de/breg-de/suche/digitalisierung-gestalten-1605002
14 https://www.bundesregierung.de/breg-de/suche/datenstrategie-der-bundesregierung-1845632
15 https://www.ki-strategie-deutschland.de/home.html
16 https://www.kmk.org/themen/bildung-in-der-digitalen-welt/strategie-bildung-in-der-digitalen-welt.html
17 http://www.bildungsplaene-bw.de/
18 https://bildungsserver.berlin-brandenburg.de/

	framework for curriculum-makers and the expansion of digitally supported education-processes, infrastructure, and equipment. In the general *Strategy of Digitalization* Berlin[19] plans to further develop the digitalization, especially in the areas of governance, smart city, infrastructure and cyber security. Digital competence is only mentioned in the context of strengthening the digital competences in the administration.
Brandenburg	The curriculum in Brandenburg dictates a compulsory independent computer science class in the "Oberschule", the "Gemeinschaftsschule" and the "Gymnasium" between the 7th and the 10th grade continuously. After that, only the "Gymnasiale Oberstufe" continues this class until the end of the school education[20]. In the *Strategy for the future – digital Brandenburg[21],* it is talked about digital participation, learning and digital competence, economy and work, attractive life, administration and law, consumer protection and data security and to strengthen the democracy. One of the goals of the *Digital Brandenburg* framework is to strengthen digital competence and digital sovereignty. In addition to that, children and teenagers should get fit for the digital world in time. Furthermore, they want to improve the educational success with the help of digital education formats and innovative pedagogical methods.
Nordrhein-Westfalen	In Nordrhein-Westfalen they developed a curriculum which includes a compulsory independent computer science class for the 7th to 10th grade in "Realschulen", "Sekundarschulen" and "Gesamtschulen". In "Gymnasien" it is only in 9th and 10th grade, also independently and compulsory. In "Gymnasialen Oberstufen" it is only in the last three years of school education. The government of NRW published the *Media Competence Framework NRW[22]*, which includes six different competence areas with four competence frames each. The competence areas are operation and usage, information and research, communication and cooperation, production and presentation, analysis and reflection and problem solving and modelling.
Schleswig-Holstein	In between the 5th and 10th grade, Schleswig-Holstein's students do have independent compulsory applied computer science courses in "Gemeinschaftsschulen" and "Gymnasien". In "Gymnasialen Oberstufen" students only have the last three years to learn computer science as an independent course.

19 https://digitalstrategie.berlin.de/haupt/de/
20 https://bildungsserver.berlin-brandenburg.de/
21 https://digitalesbb.de/digitalstrategie/
22 https://medienkompetenzrahmen.nrw/

4.2.1 Policies for Data Literacy

Baden-Württemberg	As every school type has a compulsory computer science class in 7th grade, students get basic competences in the following areas according to the *Education plan*[23]: structure and connection, modelling and implementation, communication and cooperation and analysis and evaluation. Furthermore, the contents include basic data literacy, such as information seeking and research structure, data and coding, algorithms, computers and networks and information society and data security. Furthermore, a base course media education is compulsory in 5th grade[24], including process related competencies in subject matters, activities and reflection. Content competencies required include: Information and knowledge, production and presentation, communication and cooperation, media society and basics of digital media work.
Berlin and Brandenburg	Berlin and Brandenburg have implemented a base curriculum for media education[25], following the KMK education in the digital world framework.
Nordrhein-Westfalen	The *Media Competence Framework NRW* includes specific aspects of data literacy, which include but are not exclusive to research of information, evaluation of information, assessment of information, critic of information, production of media and administration of data sources. The framework is not compulsory for curricula, but it is accepted and implemented in all schools.
Schleswig-Holstein	The digitalisation program of Schleswig-Holstein[26] highlights the strong need for media education.

4.2.2 Policies for AI

Baden-Württemberg	No policy document related to AI could be identified.
Berlin	No policy document related to AI could be identified.
Brandenburg	No policy document related to AI could be identified.
Nordrhein-Westfalen	The strategy for the digital NRW 2.0[27] strongly highlights the need for AI education.
Schleswig-Holstein	Schleswig-Holstein[28] has published an AI strategy, strongly highlighting the need for AI education.

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23 http://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/SEK1/INF7

24 http://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/GYM/BMB

25 https://bildungsserver.berlin-brandenburg.de/bcmedienbildung

26 https://www.schleswig-holstein.de/DE/Landesregierung/Themen/Digitalisierung/Digitalisierung/Digitalisierungsprogramm/digitalisierungsprogramm_node.html

27 https://www.digitalstrategie.nrw/digitalnrw/de/home

28 https://www.schleswig-holstein.de/DE/Landesregierung/Themen/Digitalisierung/Kuenstliche_Intelligenz/KI_Strategie/ki_strategie_node.html

4.2.3 Policies for Educators

Baden-Württemberg	In Baden-Württemberg, teacher further education is offered for e.g. computer science[29] and media education[30] courses, building competences in the context of the curricula requirements in those areas.
Berlin and Brandenburg	In Berlin and Brandenburg teacher further education is offered in e.g. computer science[31].
Nordrhein-Westfalen	Nordrhein-Westfalen has published a media competence framework for teacher education[32], in concert with the media competence content framework.
Schleswig-Holstein	In the *AI strategy[33]* of Schleswig-Holstein it is defined that they want to promote basic knowledge about AI in schools, as it is a prerequisite for accepting AI. Therefore, they are adapting the expertise and skills to allow an AI-oriented world of learning. As a result, the education of teachers must develop in a new way too.

4.3 Austrian policies

The Austrian model called **Digital Competence Model for Austria** (DigComp 2.2 AT)[34] is based on the DigComp 2.1. Its purpose is to classify and compare digital competences within Austria. These digital competences are split in six areas (one more than the DigComp) and eight competence levels:

Foundations and access	Understanding the concepts of digitalization
	Handling digital devices
	Using and providing inclusive forms of access to digital content
Information and data literacy	Browsing, searching and filtering data, information and digital content
	Critically evaluating and interpreting data, information and digital content
	Managing data, information and digital content
Communication and collaboration	Interacting through digital technologies

29 https://lehrerfortbildung-bw.de/u_matnatech/informatik/gym/bp2016/fb1/
30 https://lehrerfortbildung-bw.de/st_digital/medienkompetenz/medienbildung/2_bildungsplan16/basis.htm
31 https://bildungsserver.berlin-brandenburg.de/qualifizierung/weiterbildung-fuer-lehrkraefte/berufsbegleitende-weiterbildung-in-berlin/angebote-der-berufsbegleitenden-weiterbildung/massnahmen-fuer-lehrkraefte/informatik
32 https://www.schulministerium.nrw/schulpolitik-aktuell-lehrkraefte-der-digitalisierten-welt-orientierungsrahmen-fuer-die
33 https://www.schleswig-holstein.de/DE/Landesregierung/Themen/Digitalisierung/Kuenstliche_Intelligenz/KI_Strategie/ki_strategie_node.html
34 https://www.bmdw.gv.at/dam/jcr:54bbe103-7164-494e-bb30-cd152d9e9b33/DigComp2.2_V33-barrierefrei

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	Using digital technologies to share data and information and to cooperate
	Using digital technologies for social participation
	Carrying out purchases and sales
	Using appropriate forms of expression
	Managing digital identity
Digital content creation	Developing digital content
	Integrating and re-elaborating digital content
	Copyright and licenses
	Programming and automating processes
Safety	Protecting devices
	Protecting personal data and privacy
	Protecting health and well-being
	Protecting oneself and others against fraud and consumer rights abuse
	Protecting the environment
Problem solving and continuing learning	Solving technical problems
	Identifying needs and technological responses
	Creatively using digital technologies
	Identifying digital competence gaps

Additionally to the DigComp 2.2 AT, Austria has designed another competence-model called the **digi.komp**[35]. It ensures the integration of digital competences in the Austrian curriculum and the pedagogical approaches. The digi.komp includes compulsory requirements on all levels of education – from primary school to secondary level 2. There are four different areas depicted:

1. *Information technologies, human and society* – usage and understanding of digital media, communication on the internet, personal security online, continuous learning and development of digital competences.
2. *Information systems* – usage of digital technologies, knowledge of computer-hardware, knowledge of networks and operating systems.
3. *Applications* – usage of common applications, creation of digital content with different applications, searching for information with different services and efficient usage of communication services.
4. *Concepts* – knowledge of common information concepts, understanding of the functionality of programs and automated processes, first steps into computational thinking and problem solving.

On the side of educators, the Austrian government published the **digi.kompP –** *digital competences for educators*[36]. It can be used to self-assess these competences and to encourage the continuous professional development of pedagogical personnel. Also, the competences covered are the base of the digital skillset each student of

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35 https://digikomp.at/
36 https://digikomp.at/digikompp/kompetenzmodell

teaching professions at the start and the end of his education and each educator after five years of working should have.

The **Artficial Intelligence Mission Austria 2030 (AimAT)**[37] addresses the development of AI applications in Austria until 2030. There are many areas of application present in the document and one of them is *Qualification and Training.* It is stated that citizens need to have digital skills for productive and fearless use of AI. Furthermore, AI specific competences need to have a place in education at schools and universities as they can help students to make learning more exciting and less time-consuming.

4.3.1 Policies for Data Literacy

As discussed before, the digi.komp contains compulsory guidelines for curricula. The first of four points of the digi.komp is *Information technologies, humans and society.* It describes the ability of students to use digital media responsibly and avoid harm to themselves or others. Additionally, it is stated that it is an important skill to critically question the use of digital media for life and society and to understand the mechanisms that are used to process information on the internet.

Also, in the third point – Applications – it is mentioned, that students should acquire the skill to precisely research information and other media with different services and applications. The DigComp 2.2 AT is, like the DigComp of the EU, a framework for education-personnel and curriculum-makers, therefore it is not binding, rather it is recommending topics to be included. Especially in focus of data literacy, point 1 information and data literacy suggests education for browsing, searching and filtering data and other digital media. Additionally, it should be critically evaluated and the skill to interpret the found data is also mentioned. Lastly, it describes the crucial ability to manage information and data. In point 2.2 – communication and collaboration – it is indicated that students should have the knowledge to use digital technologies to share and collaborate on data and information.

4.3.2 Policies for AI

The future development of AI in education was also discussed by experts and the results were published in a results evaluation document[38]. The first one of the recommended actions is the strengthening of MINT-education and AI competence education, which could look like the promotion of women in MINT, a stronger focus on general digital education and AI in pedagogical concepts, support for schools on using the possibilities to create main emphasis in the area of AI or many more. Also, the integration of AI in education of teaching-students is one of the main actions, which consists of for example the strengthening of media- and digital concepts and AI-application-competences of educators or the preparation of a platform to represent different AI-products. The third point contains some actions for integration of AI in research and education at universities, while the fourth point is about the usage of AI by teachers and students. The last action is about the support of the cooperation between science, economy and society.

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37 https://www.bmdw.gv.at/Themen/Digitalisierung/Strategien/Kuenstliche-Intelligenz.html
38 https://www.bundeskanzleramt.gv.at/dam/jcr:094fa5af-1acc-4238-8d7e-e27351005d45/15_13_bei_NB.pdf

digi.kompP (as well as digi.komp12) includes topics for 'intelligent systems' which clearly focuses on AI with competences for knowing the difference between human and machine intelligence as well as applying intelligent informatics systems.

4.3.3 Policies for Educators

As stated in the digi.kompP category A, educators should have a wide range of data literacy specific abilities. These contain but are not exclusive to finding information sources, using networking methods to gain information, having knowledge about basic digital information-management and choosing a relevant and qualitative data and information finding method. Also they should have basic knowledge about technology and computers and many others regarding accessibility of and teaching with technology.

4.4 Lithuanian policies

Similar to Austria, Lithuania uses both the European and a national definition of digital competences. These competences are integrated in other compulsory subjects in primary education. Also, Lithuania and Cyprus do have the highest number of allocated hours of information and communication technologies in lower secondary education, in comparison to other European countries. In contrast to that, there is not a recommendation for how many hours there should be in primary education. Also, primary IT-specific competences are not assessed but in general upper secondary education students have national tests for digital competences, but only students on a particular educational pathway or students who specifically chose to get tested are being subject to assessment.

Since 2018, Lithuania deployed a pilot project for a curriculum framework for the subject 'informatics' in primary education. The competences include digital content, data and information, problem solving, algorithms and programming (even with mention to specific programming languages), virtual communication and security and legal aspects.

4.4.1 Policies for Data Literacy

The European Euridyce report[39] shows, that Lithuania has included information and data literacy related competences like evaluating data, information and digital content, in the curriculum for all general school levels – ISCED 1-3.

4.4.2 Policies for AI

In the *AI Strategy*[40], Lithuania published different policy recommendations regarding the use and future of AI in Lithuania. One of these, principle 1 on page 15, regards the specific education to develop skills needed for AI from the start of education. They want to achieve this by using different mechanisms. Students should be taken to businesses, which are innovating AI products to get examples and real-life experience of new technologies. Also, there should be classwork for students for

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39 https://op.europa.eu/en/publication-detail/-/publication/d7834ad0-ddac-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-105790537

40 https://eimin.lrv.lt/uploads/eimin/documents/files/DI_strategija_ENG(1).pdf

learning the basics of AI. Especially in regional districts, the focus on developing digital skills will be strengthened. By modernizing specific subjects like STEM and at the same time the education of teachers will provide possibilities to teach students how to use technologies integrated into other subjects.

4.4.3 Policies for Educators

Again, like Austria, Lithuania has developed a specific framework for digital competences for teachers[41]. It helps to assess and map competences that are essential for teaching with the use of technologies. Also, teachers are obliged to use the framework for continued development of their digital competences.

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41 https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/599d489078af11e89188e16a6495e98c?jfwid=q8i88m58y2

5. Document Overview

The following table provides a summary of policy documents for the EU, Germany, Austria and Lithuania. This represents the first results of the desk research and stakeholder workshops and forms the basis for subsequent deliverables.

	Issuer	Target audience	Type	Issuing year	Source
European Union					
The Digital Competence Framework for Citizens (DigComp)	Joint Research Center (JRC), the EC science and knowledge service	Policy makers for education	Reference frame	2017	https://publications.jrc.ec.europa.eu/repository/handle/JRC106281
European Framework for the Digital Competence of Educators (DigCompEdu)	Joint Research Center (JRC), the European Commission science and knowledge service	Policy makers for education	Reference frame	2017	https://publications.jrc.ec.europa.eu/repository/handle/JRC107466
Digital education action plan 2021-2027	European Commission	Policy makers for education	Action plan	2021	https://ec.europa.eu/education/education-in-the-eu/digital-education-action-plan_en
Germany					
(DE) Shaping Digitalization	The German federal government	Policy makers including but not limited to education	Strategy	2021	https://www.bundesregierung.de/breg-de/suche/digitalisierung-gestalten-1605002
(DE) Data strategy of the federal German government	The German federal government	Policy makers including but not limited to education	Strategy	2021	https://www.bundesregierung.de/breg-de/suche/datenstrategie-der-bundesregierung-1845632
(DE) Artificial Intelligence Strategy of the German Federal Government	The German federal government	Policy makers including but	Strategy	2020	https://www.ki-strategie-deutschland.de/home.html

		not limited to education			
(DE) Education in the digital world	The Standing Conference of the Ministers of Education and Cultural Affairs	Policy makers for education	Strategy	2016	https://www.kmk.org/themen/bildung-in-der-digitalen-welt/strategie-bildung-in-der-digitalen-welt.html
(BW) Digitalisation stragegy	The federal state government of Baden-Württemberg	Policy makers including but not limited to education	Strategy	2017	https://im.baden-wuerttemberg.de/de/digitalisierung/digitalisierungsstrategie/
(BW) Education plan 2016 - Media education	Ministry for culture, youth and sports Baden-Württemberg	Educators for young people (~11)	Curriculum	2016	http://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/GYM/BMB
(BW) Education plan 2016 - Computer science	Ministry for culture, youth and sports Baden-Württemberg	Educators for young people (~13)	Curriculum	2016	http://www.bildungsplaene-bw.de/,Lde/LS/BP2016BW/ALLG/SEK1/INF7
(BW) Teacher further education - Media education (Education plan 2016)	Teacher further education Baden-Württemberg	Educators for young people	Teacher further education	2016	https://lehrerfortbildung-bw.de/st_digital/medienkompetenz/medienbildung/2_bildungsplan16/basis.htm
(BW) Teacher further education - Computer science (Education plan 2016)	Teacher further education Baden-Württemberg	Educators for young people	Teacher further education	2016	https://lehrerfortbildung-bw.de/u_matnatech/informatik/gym/bp2016/fb1/
(BE) Greenbook for the strategy of digitalization	Senate department for economy, energy and business	Policy makers including but not limited to education	Strategy	2021	https://digitalstrategie.berlin.de/haupt/de/
(BE, BB) Base curriculum media education	Berlin / Federal state of Brandenburg	Educators for young people (~6-16)	Curriculum	2017	https://bildungsserver.berlin-brandenburg.de/rlp-online/b-fachuebergreifende-kompetenzentwicklung/basiscurriculum-medienbildung/standards/

(BE, BB) Computer science further education	Berlin / Federal state of Brandenburg	Educators for young people	Teacher further education	2021	https://bildungsserver.berlin-brandenburg.de/qualifizierung/weiterbildung-fuer-lehrkraefte/berufsbegleitende-weiterbildung-in-berlin/angebote-der-berufsbegleitenden-weiterbildung/massnahmen-fuer-lehrkraefte/informatik
(BB) Strategy Paper Digital Brandenburg	Federal state of Brandenburg	Policy makers including but not limited to education	Strategy	2018	https://digitalesbb.de/digitalstrategie/
(NRW) Strategy for the digital NRW 2.0	The federal state government of Nordrhein-Westfalen	Policy makers including but not limited to education	Strategy	2021	https://www.digitalstrategie.nrw/digitalnrw/de/home
(NRW) Digital strategy for schools in NRW	Ministry for school and education (NRW)	Policy makers for education	Strategy	2021	http://www.broschueren.nrw/digitalstrategie/home
(NRW) Media competence framework	The federal state government of Nordrhein-Westfalen	Educators for young people (~6-18)	Model of competence	2020	https://medienkompetenzrahmen.nrw/
(NRW) Educators in the digital world	Ministry for school and education (NRW)	Educators for educators	Model of competence	2020	https://www.schulministerium.nrw/schulpolitik-aktuell-lehrkraefte-der-digitalisierten-welt-orientierungsrahmen-fuer-die
(SH) Digitalisation program	Ministry for energy transition, agriculture, environment, nature and digitalisation (SH)	Policy makers including but not limited to education	Strategy	2021	https://www.schleswig-holstein.de/DE/Landesregierung/Themen/Digitalisierung/Digitalisierung/Digitalisierungsprogramm/digitalisierungsprogramm_node.html

(SH) Artificial Intelligence strategy	The prime minister of the federal state of Schleswig-Holstein	Policy makers including but not limited to education	Stragegy	2021	https://www.schleswig-holstein.de/DE/Landesregierung/Themen/Digitalisierung/Kuenstliche_Intelligenz/KI_Strategie/ki_strategie_node.html
Austria					
Digital competence model for Austria (DigComp 2.2 AT)	The Federal Ministry for Digital and Economic Affairs	Policy makers for education	Reference frame	2021	https://www.bmdw.gv.at/dam/jcr:54bbe103-7164-494e-bb30-cd152d9e9b33/DigComp2.2_V33-barrierefrei
Artificial Intelligence Mission Austria 2030 (AimAT 2030)	The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation, and Technology; The Federal Ministry for Digital and Economic Affairs	Policy makers including but not limited to education	Strategy	2018	https://www.bmdw.gv.at/Themen/Digitalisierung/Strategien/Kuenstliche-Intelligenz.html
digi.komp4 model of competence	The Federal Ministry of Education, Science and Research	Educators for young people (~6-10)	Model of competence	2016	https://digikomp.at/digikomp4/kompetenzmodell
digi.komp8 model of competence	The Federal Ministry of Education, Science and Research	Educators for young people (~10-14)	Model of competence	2016	https://digikomp.at/digikomp8/ueber-digikomp8
digi.komp12 model of competence	The Federal Ministry of Education, Science and Research	Educators for young people (~14-18)	Model of competence	2016	https://digikomp.at/digikomp12/informatik
digi.kompP model of competence	The Federal Ministry of Education,	Educators for educators	Model of competence	2016	https://digikomp.at/digikompp/kompetenzmodell

	Science and Research				
Lithuania					
Lithuanian Artificial Intelligence Strategy	Ministry of the Economy and Innovation	Policy makers including but not limited to education	Strategy	2019	https://eimin.lrv.lt/uploads/eimin/documents/files/DI_strategija_ENG(1).pdf
Description of Requirements for Teachers and Student Support Professionals for Digital Literacy Programs	The Minister of Education and Science of the Republic of Lithuania	Educators for educators	Model of competence	2018	https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/599d489078af11e89188e16a6495e98c?jfwid=q8i88m58y2

6. Conclusions and policy monitor recommendations

Following the initial analysis of policy documents in the European and national context relevant to this project, several conclusions as well as recommendations for the development of a policy monitor (compare system) in this context can be drawn.

1. It has been observed that in the education policy context there is a quite divers set of relevant policy documents on different levels, from high-level strategy documents to detailed curricula implementations. Furthermore, different nation states are at different levels of policy implementation, but in all national case studies we investigated, data literacy, AI and teacher education are considered at some level. The recommendation for policy monitor development is that a wide variety of policy documents needs to be taken into account in order to capture the implementation state of education in those areas. We have identified the following classes of policy documents that should be considered by the policy monitor: strategy documents, action plans, reference frameworks, curriculum frameworks, models of competence, curricula and teacher further education policy documents.

2. Since such a wide variety of policy documents need to be investigated in order to capture the implementation state of data literacy, AI and teacher education in this context, it is important to consider the core target audience of specific policy documents. While ultimately learners and educators are the main target audience of education policies, policy makers are the main target audience of higher-level strategy or policy documents. Following target audience groups could be identified and should be considered by the policy monitor: Policy makers including but not limited to education, policy makers for education, educators, educators for educators.

3. Different member states have different approaches to education policies. While it is national responsibility in several project member states, the example of Germany shows a strong autonomy of the federal states in generating and implementing education policies. In such cases it is not sufficient to only consider national policies in a policy monitor, but it is recommended to assess regional policies individually (e.g. on a federal state level).

4. In order to be able to assess the content relevance of data literacy and AI in the individual policy documents, it is necessary to derive a set of indicators that cover the core aspects of data literacy and AI in the education context. After evaluation of the available literature and in relation to the definitions described in Section 3, it is recommended to create a compare system that assesses data literacy according to following criteria derived from the DigiComp: **(1)** Browsing, searching and filtering data, information and digital content, **(2)** Evaluating data, information and digital content, **(3)** Managing data, information and digital content. Furthermore, it is recommended to assess AI according to following criteria derived from the „Dagstuhl-Dreieck": **(1)** Technical aspects of AI, **(2)** Social and cultural aspects of AI, **(3)** Application related aspects of AI.

5. Due to the wide variety of policy documents to be considered, the identification of specific content aspects which are covered by a policy document is expected to be difficult. The ability to clearly match content areas in a true or false valuation is expected to be impossible, therefore a finer graduation of the valuation system is required. At the same time, a too fine graduation may sacrifice clarity of the aspects to be monitored by policy indicators. It is therefore recommended to use a simple graduation consisting of three states, indicating that an indicator criterion of the compare system is **(1)** covered, **(2)** partially covered, **(3)** not covered.

6. It has been observed that policies related to teacher education usually either refer to or follow the same competence framework than is implemented in or proposed for the education curricula at different levels of education. On top of that, teacher education policies propose or implement pedagogical and didactical competences that enable educators to take full advantage of teaching aids and approaches available to teach specific competences. It is therefore recommended that the policy monitor assesses, in addition to evaluating content indicators for data literacy and AI, whether a policy document addresses pedagogical and didactical competences.