Train DL

Teacher training for Data Literacy & Computer Science competences

D5.9 - Set of consolidated recommendations

train-dl.eu

1. Executive summary

This deliverable is the final in a series of deliverables presenting iterations of the TrainDL policy recommendations for CS (Computer Science), STEAM (Science, Technology, Engineering, Arts, Mathematics) and primary school education, following the iterative approach of TrainDL policy experimentation.

This final deliverable presents a consolidated set of CS, STEAM and primary school recommendations, as the outcome of several iterations of policy dialogue, intervention and evaluation, as summarised in Section 2 of this deliverable. The outcomes of previous iterations were presented in D5.3/D5.4 (CS), D5.5/D5.6 (STEAM) and D5.7/D5.8 (primary). A summary of the most relevant background material for policy research is discussed in Section 3, and a summary of the lessons learned from previous iterations that informed the presentation of this final set of consolidated policy recommendations can be seen in Section 4.

The policy recommendations for CS, STEAM and primary school education are presented in Section 5, Section 6 and Section 7 respectively. As compared to previous iterations, the recommendations for CS saw the biggest adaptations, given that those were the first recommendations worked on in the project, and subsequent iterations of dialogue and experimentation with stakeholders lead to a change in the approach how policies are presented, as further detailed in the lessons learned discussed in Section 4. In this final iteration, all recommendations are grouped according to a topical focus, with each recommendation containing one or more points to be addressed to improve the situation related to this recommendation. For this final iteration it was decided to add, for each point made in the recommendations, also a clear "Motivation" as to why this point was made, linking each aspect of a recommendation to a tangible outcome of the TrainDL policy experimentation (policy dialogue, interventions, evaluations). Through this it can be shown that all recommendations are based on experimentation, and on the issues highlighted or input given by the stakeholders of this project. In addition to this, a compact table that lists all TrainDL policy recommendations for CS, STEAM and primary education is provided in Annex 1 of this deliverable.

Finally, Section 8 of this deliverable concludes this work and gives an outlook on potential future work, which will focus on trying to disseminate and operationalise the recommendations at different levels (from how AI&DL education is considered at the political level, down to how to implement AI&DL education in curricula and schools). Besides continuing to work with the relevant stakeholders that were part of this project in the partner countries of Germany, Austria and Lithuania (as well as interested stakeholders beyond that), suggestions for dissemination and operationalisation of the recommendations given by the stakeholders of the final policy dialogue workshop will be considered. Those include fostering collaborations with relevant institutions, programs and authorities (on national, EU and global level), considering additional marketing activities to promote the TrainDL project including the recommendations, or to organise/participate in competitions to get in contact with the target group of pre-service/in-service teachers.

2. TrainDL policy research methodology

The TrainDL project generally follows an action research approach. The project iterates three times through a life cycle consisting of three phases, as illustrated in Figure 1:

1. the policy dialog & building with a close integration / consultation of public authorities, policy makers, advisory board and stakeholders **(TrainDL work packages (WP) 1 & 5** as well as **WP 6 & 7)**
2. the intervention with the field research and experimentation phase **(TrainDL WP 2 & 3)**
3. the evaluation of micro (pedagogical), meso (organizational/structural, and macro (policy) level dimensions **(TrainDL WP 4)**

With this approach, the existing gaps and the current situation in the field of digital education policies were identified and analysed in order to develop the policy recommendations for the three target groups. The preliminary work and the final creation of the policy recommendations are part of the first project phase, the policy dialog & building. This deliverable forms part of the final aspect of this methodology, the policy reporting phase by disseminating the policy recommendations the research resulted in.
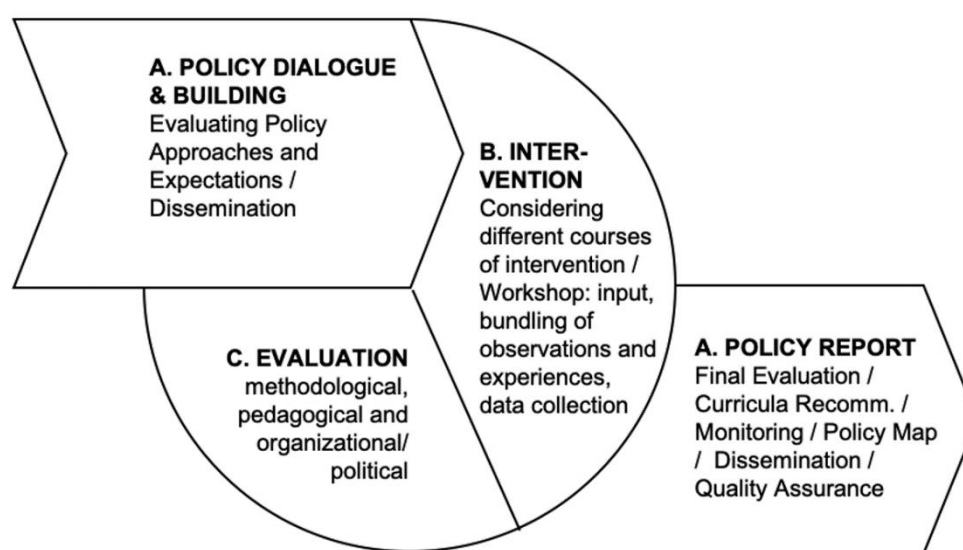

Figure 1: The TrainDL policy research cycles[1]

The scientific methodology consists of in-depth desk research, stakeholder workshops and interventions with the target groups, as illustrated in Figure 2.

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[1] TrainDL Project Approach [Online]. Available: https://train-dl.eu/ueber-traindl/projekt [Accessed 11 03 2024]
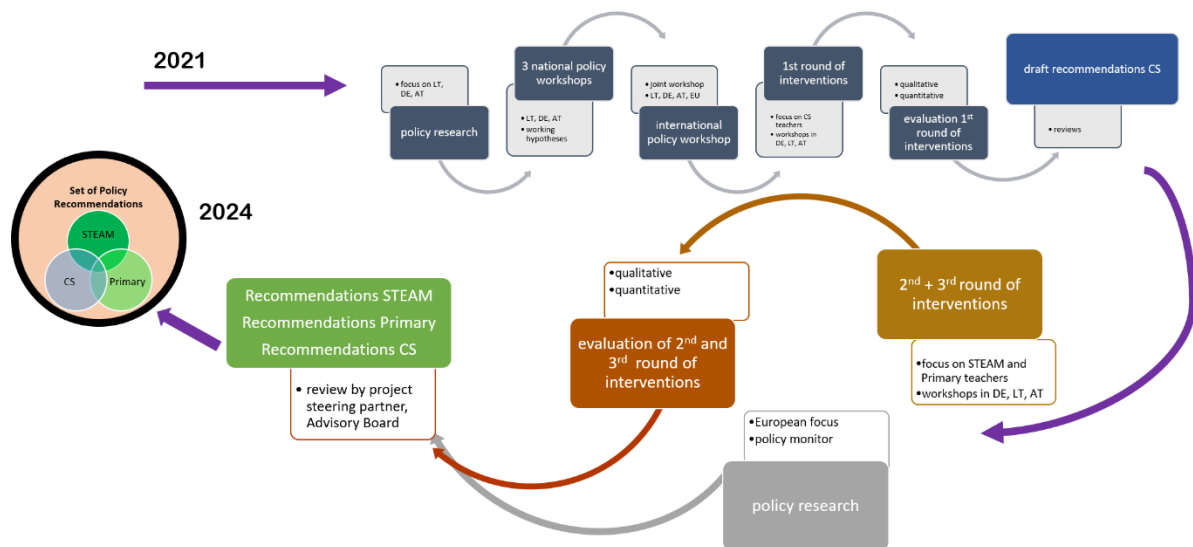
Figure 2: The TrainDL policy research methodology

The first step was to conduct a detailed desk research to identify all relevant policy documents and to have a knowledge base for the development of initial policy recommendations for the integration of AI&DL with the focus on CS education. In the course of the research, 77 policies from more than 20 countries, the EU and globally were analysed, and are visualised via the TrainDL online policy monitor developed during the project[2] (WP 1).

The next step in the iterative process was the organisation of stakeholder workshops. Altogether three national workshops were held in Germany, Austria and Lithuania as well as an international policy workshop with public authorities, policy makers, researchers, teacher education institutions (WP 1). In the course of these workshops, relevant factors were identified which should be considered for the integration of AI&DL in the different school levels. Ultimately, based on these workshops, guidelines were derived for interventions with the teachers of the target groups. In the following, these interventions were held with the teachers of the target groups (CS, STEAM, Primary). A total of three rounds of interventions in the project partner countries Germany, Austria and Lithuania (WP 2&3) were implemented. The interventions were developed and conducted in accordance with the guidelines derived from the input from the stakeholder/policy workshops (WP 1) and evaluated quantitatively and qualitatively afterwards (WP 4).

Finally, the set of policy recommendations for CS, STEAM and primary school teachers was formulated based on the results of the evaluation (WP 4) and were reviewed once again by the project steering partner and the advisory board (WP 7).

As a result of this iterative process, in this deliverable a consolidated set of policy recommendations was finalized, also taking into account the feedback received during the final policy dialogue workshop as part of the TrainDL summit (WP 1&6).

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[2] TrainDL Policy Monitor [Online]. Available: https://traindl-policymonitor.ocg.at/. [Accessed 11 03 2024].

3. Policy research - background and related work

One of the most important sources during the desk research regarding AI/DL policies was the Digital Education Action Plan[3]. In this action plan, the EU recognises the need for closer European cooperation in digital education in order to keep pace with the rapid developments in this field. The initiative proposes a total of 14 actions, including actions on Data Literacy and Artificial Intelligence with a focus on education.

The Digital Education Action Plan is still ongoing and new actions are regularly published and existing actions further expanded. Most of the European Council Recommendations address the topics of AI&DL, including in the context of education. The most relevant actions for TrainDL so far are actions 6, 8, 9, 10 and 11.

Action 6 deals with the topic "Ethical guidelines on the use of AI and data in teaching and learning for educators".

Action 8 is titled "Updating the European Digital Competence Framework to include AI and data-related skills" and deals with the update and further expansion of the DigComp Framework (described in detail below).

Action point 9 focuses on the "European Digital Skills Certificate" (EDSC). This certificate is intended to help people classify and have their digital skills recognised. The certificate is currently still under development and will be based on the European Digital Competence Framework (DigComp).

Action 10 contains the "Council Recommendation on improving the provision of digital skills and competences in education and training. These recommendations encourage member states to integrate digital technologies and topics such as AI into teaching and to enable teachers to use these technologies and pass on the knowledge to their students.

Action 11 "Cross-national collection of data and an EU-level target on student digital skills" deals with internationally comparable data with the aim of mapping digital skills and factors influencing their acquisition within the EU.

The European Union published the first version of the European Digital Competence Framework (DigComp) in 2013[4]. In 2022, the updated version DigComp 2.2[5] was published. The framework defines data literacy as one of five competence areas. Data from 57 countries was collected and analysed for DigComp 2.2. In addition to DigComp 2.2, a framework with a special focus on digital skills for teachers was published, the Framework for the Digital Competence of Educators (DigCompEdu[6]).

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[3] European Commission, "Digital Education Action Plan 2021-2027," 2020. [Online]. Available: https://education.ec.europa.eu/de/focus-topics/digital-education/action-plan. [Accessed 11 03 2024].

[4] S. Carretero, R. Vuorikari and Y. Punie, *DigComp 2.1: The digital competence framework for citizens,* Joint Research Centre (European Commission), 2017.

[5] R. VUORIKARI Rina, S. Kluzer and Y. Punie, "DigComp 2.2: The Digital Competence Framework for Citizens - With new examples of knowledge, skills and attitudes," Publications Office of the European Union, Luxembourg, 2022.

[6] C. Redecker, "European Framework for the Digital Competence of Educators: DigCompEdu," Publications Office of the European Union, Luxembourg, 2017.

UNESCO has published a Global Framework of Reference on Digital Literacy Skills for Indicator 4.4.2[7]. The framework indicates the percentage of young people/adults who have achieved at least a minimum level of digital competence. In this report, the definition of literacy skills is based on the data from the DigComp Framework mentioned above. Based on the data from the DigComp Framework, the UNESCO report presents a global framework for data literacy, which provides an overview of the existing digital competence frameworks worldwide.

The European Commission has also published a report on digital education policies, the "Digital Education Policies in Europe and Beyond[8]" report. The report from 2017 analyses and summarizes policies from EU countries and selected countries outside the EU. The report focuses on highlighting key enablers, success factors and barriers to provide guidance to policy makers at local, regional, national and international levels. Of the more than 40 policy initiatives, six initiatives from Estonia, Ireland, Poland, Australia, Canada and Malaysia were examined in detail. The report provides a good overview, but lacks an evaluation of the content and the aspect of teacher training. The initiative focuses exclusively on the understanding of digital technologies in the classroom and the creation of teaching capacities, in particular the improvement of teachers' skills in the use of digital teaching technologies.

Another important source in the desk research was the AI4T Erasmus+ K3 project[9]. The project aims to support teacher training in the field of AI for and with teachers. In the project, a course is designed for secondary school teachers to teach them how to use AI tools. The project has also published several policy recommendations on this topic, which emphasize, among other things, the provision of materials, the need for a clear learning pathway for teacher training, and ethical and legal considerations when using AI in Education.

In the field of AI education policies, the OECD, the Organisation for Economic Co-operation and Development, has developed the OECD AI Policy Observatory[10], which serves as a multidisciplinary repository and visualization of the relevant policies. The policies and information can be filtered by country. In addition, various trends and data can be visualized, for example the number of AI courses in English by educational level in the various countries. The OECD Policy Observatory refers to the various data sources used to create the graphics.

4. Review of and lessons learned from previous iterations of policy research

From the work on the draft CS policy recommendations in D5.3 and D5.4 we have learned that the devised policy recommendations are in principle valid. However, the chosen structure of these draft recommendations has been highlighted as a point

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[7] N. Law, D. Woo, J. de la Torre and K. Wong, *A global framework of reference on digital literacy skills for indicator 4.4.2,* 2018.

[8] J. Conrads, M. Rasmussen, N. Winters, A. Geniet, L. Langer, C. Redecker, P. Kampylis, M. Bacigalupo and Y. Punie, "Digital education policies in Europe and beyond," *JRC Science for policy report,* 2017.

[9] AI4T project. . [Online]. Available: https://www.ai4t.eu/about/. [Accessed 11 03 2024].

[10] OECD, "OECD.AI," 2023. [Online]. Available: https://oecd.ai/en/dashboards/overview. [Accessed 11 03 2024].

for potential improvements during the review by the project steering committee and the stakeholders. For this first iteration of policy recommendations, a structure was chosen that identified the focus of the policy area, and then provided actionable mechanisms to implement policy actions in that area. The suggestion was to not identify concrete actionable items at this point in the policy process, but highlight the possibilities in a less direct way as to give stakeholders taking up those recommendations the required freedom to implement the actions according to their specific environment and needs. The lesson learned from this was that the draft STEAM and primary recommendations were structured as high level recommendations. For this final iteration – the set of consolidated recommendations - also the CS recommendations were restructured to follow this approach, as the feedback from STEAM and primary recommendation reviews was positive about this new structuring of the recommendations.

Content specific lessons learned from D5.3 and D5.4 reviews were that teacher training is of central importance and should be highlighted more. This was of course already evident from policy experimentation, and was further highlighted in this final iteration. Evidence from reviews has clearly shown that also CS teachers would greatly benefit from ready-to-use materials.

From the reviews of STEAM and primary school policy recommendations of D5.5/D5.6 (STEAM) and D5.7/D5.8 (primary school) we have learned that again, the core of the recommendations are valid and in line with the experiences of the stakeholders reviewing the recommendations. It was clearly highlighted that the recommendations towards ready-to-use and well-prepared teaching material is crucial, and that AI&DL needs to be integrated in a meaningful way into the core topics of STEAM subjects. Proper training and further education of teachers is essential, as highlighted by the recommendations. We have learned that no major revisions of the policy recommendations will be required for this final iteration of the policy recommendations. Only minor adaptations, for example to address input from the final policy dialogue workshop (reported in D1.12) were required.

5. Policy recommendations for CS teachers

The following table shows the revised and consolidated policy recommendations for CS teachers. Starting point for the policy recommendations for CS teachers is the draft/prototype of the policy and curricula recommendations (CS teachers) from deliverable D5.3. These initial working observations/theses and draft policy recommendations represented were based on (a) state-of-the-art analysis of relevant policy documents and definition of a policy monitor, as reported in D1.1 and D1.2; (b) national policy dialog workshops in the context of WP 1 with project relevant stakeholders (policy makers and representatives from education institutions from Germany, Austria and Lithuania), as reported in D1.3; (c) the Joint international policy building workshop, as documented in D1.6 as well as (d) the refinement of the policy recommendations based on the evaluation (WP 4) of the outcomes of the first round of interventions with CS teachers conducted in the context of WP 2. Furthermore, the initial policy recommendations were phrased based on the analysis of stakeholder expectations, success factors and potential challenges derived from those workshops, as presented in D5.2.

In deliverable 5.4, the initial policy recommendations for CS teachers were assessed by experts and the feedback was incorporated into the adapted observations/thesis and policy recommendations.

The policy recommendations for CS teachers were reviewed and revised again for this deliverable D5.9 – the set of consolidated recommendations. In addition to the sources already mentioned above, the evaluations from WP4 (D4.4, D4.5, D4.6 and D4.7) and the results from the interventions on secondary education from WP 2 were considered. In addition, the results from D1.12 (final policy dialogue workshop) were considered in this final iteration of the TrainDL policy recommendations for CS teachers.

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Policy Recommendation 1 (Focus and Methods) cs

Ready-to-use materials: For teachers, in order to support the integration of AI&DL into their teaching, ready-to-use teaching materials developed and tested by qualified experts, as well as tools and courses, that enable a constructionist approach and tailored to the school level, need to be provided.

Motivation

The target groups / teachers gave positive feedback on the provided materials in the interventions. More content depth, immediate applicability, and better tailoring to different grade levels and students' didactic needs were mentioned as improvements / further development of the materials.

Connection of AI&DL to the subjects: It is also essential to emphasize the connection of AI&DL to the teachers' specific subjects to prevent the topics of AI&DL from becoming additional responsibilities. Making the connection between subjects and AI&DL is important, as without background knowledge this may be difficult for a teacher to recognise. In this regard, it is important to provide guidelines for the integration into subjects, complementary to the ready-to-use materials.

Motivation

One of the challenges of integrating AI&DL into the classroom is that teachers do not see the connection of these topics to their subjects. In the feedback on the interventions both CS and STEAM teachers particularly appreciated the content that relates specifically to their subject areas (also besides CS) which establish a connection to their specific subjects and therefore facilitate the integration of AI&DL into the timetable.

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Contents and Tools: Providing tools and guidance on how to use them and what benefits they can bring to the respective subjects is also of central importance. The content of the teacher training should not focus solely on technical aspects but also on the application of the knowledge as well as risks and opportunities of AI&DL.

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Motivation

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The teachers in the interventions also asked about concrete steps for integrating the topics of AI&DL into their lessons. For example, websites, tools and computer programs or practical concepts as well as materials or other resources.

Raising awareness: It is important to make teachers aware of the increasing relevance of AI&DL in teacher training, with a particular focus on the importance of these topics in the field of education, so that they can pass this knowledge on to their students in an appropriate way.

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Motivation

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The feedback from all target groups in all three interventions as well as the input of the stakeholders recognised and mostly highlighted the importance of AI&DL in the different school levels and see the integration into the classroom as the right and necessary step.

Potential benefits: Teacher training courses should highlight the potential advantages of integrating AI&DL not just within classroom lectures but also in further activities. These activities may encompass the creation of teaching materials, brainstorming ideas for class topics, or incorporating AI&DL into lesson planning and administrative tasks for educators.

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Motivation

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The teachers of the target groups support the integration into the classroom, as the topics and technologies are becoming more and more relevant in today's society. It is therefore important to demonstrate the benefits and applications for teachers outside of the classroom, in addition to the activities and teaching content for students.

Potential risks, ethical aspects & data protection: It is essential that teachers are informed about the potential risks and ethical aspects that the use of AI&DL can entail and also pass this knowledge on to their students. In this context, the topic of data protection should also be part of the teacher training.

Motivation
In addition to the many benefits, the risks must also be highlighted. Stakeholders in the workshops and the research as wells as feedback from the target groups have shown that the risks (e.g. over-automation, data bias, fake news), ethical aspects and data protection aspects must also be taken into account in order to ensure a meaningful and sustainable integration.

Constructivism, unplugged approach: In general, teacher training and the utilization of AI&DL and related tools should prioritize a constructivist, hands-on approach. For teachers and students alike, embracing this method alongside unplugged methodologies as well as acquiring personal experience with AI&DL and its tools proves to be a promising strategy for getting started with, or even delving further into the topic.

Motivation
In principle, there was a request from all three target groups for more hands-on activities and practical approaches in the interventions. Stakeholder input in the workshops also mentioned unplugged approaches, especially to convey and understand the basics of AI&DL.

Self-assessment test: In order for in-service CS teachers to know what objective knowledge about AI&DL they already have or in which areas they need to improve, a self-assessment test of their factual AI&DL knowledge is recommended.

Motivation
The results of the interventions showed that the AI self-assessment and knowledge test had a positive influence on the participants' evaluation of their own knowledge level. The teachers were therefore better able to assess their level of knowledge with the help of the tests. This recommendation was included especially for CS-teachers, as this target group is assumed to have background knowledge of AI&DL topics and therefore a classification makes sense.

Policy Recommendation 2 (Teacher Training Formats for In-Service Teachers) CS

Course formats: There are various options for organising the courses for teacher trainings. In any case, a combination of different course formats should be used. Overall, there is the option of on-site education, online education, hybrid settings, blended-learning or flipped classrooms. Ideally, the courses should take place in a modular setting, i.e. a series of training sessions.

Motivation

The interventions have shown that different and flexible course formats for teacher training are needed in order to meet the needs of the teachers as well as real-life constraints (e.g. available time, requirements of educational authorities, etc.).

Teaching process: The training of teachers should include a combination of on-site courses and online course modules. The courses should include modules to introduce the topics of AI&DL and the general concepts and course content, as well as supplementary course modules to cover specific topics in greater depth. This will optimally complement teacher training and allow teachers to acquire in-depth knowledge of the topics and explore tools and activities independently in the online course formats at their own pace.

Motivation

Stakeholders, teachers and education experts have recommended a modular setting for the teacher training courses, as modular courses allow content to be divided up and dealt with in the best possible way.

Course structure: In order to keep motivation high in the courses, a clear structure should be presented whereas each course unit should have clearly defined learning objectives which teachers will achieve at the end of the unit.

Motivation

Feedback from experts and project partners has emphasized the importance of (learning) objectives for the teacher training in order to clearly define what is to be achieved in the course units.

Feedback mechanisms: Incorporating feedback sessions into teacher training programs, whether in-person or virtual, allows educators to provide constructive feedback on the integration of AI&DL concepts into their actual teaching practices.

Motivation
In bilateral discussions with project partners and as a result of external expert review as well as feedback suggestions from the target groups, the point of feedback mechanisms was included in the recommendations, as regular feedback is important for the successful integration of AI&DL into school education and makes this process easier for teachers.

Policy Recommendation 3 (Education for Pre-Service Teachers) cs

The topics of AI&DL should already be included in the training of pre-service teachers at university and should become an integral part of the teacher training curriculum.

Motivation
The interventions have shown that both CS and STEAM teachers see the need and importance of integrating AI&DL subjects and topics into the university programs for future teachers.

Policy Recommendation 4 (Framework Curricula) cs

AI&DL subjects should carefully be integrated into framework curricula, as these are already mostly overfilled. It is important to be careful not to risk a loss of interest in AI&DL by further overfilling the compulsory courses. This may require existing content in the curriculum to be reprioritized.

Motivation
In all three countries feedback has shown that the integration of AI&DL subjects and topics into the framework curriculum is necessary. CS teachers have expressed the wish for AI&DL to become a separate mandatory subject. In Austria and Germany in particular, the feedback indicated that the curricula are already tightly packed and that the existing subjects need to be reprioritized in order to integrate new topics/subjects. Some of the teachers interviewed believe that the successful integration of AI&DL into the framework curriculum is subject to a number of conditions. E.g.: the implementation of the plans in the classroom and the availability of resources. In addition, the teachers interviewed emphasized the already existing workload for teachers.

Policy Recommendation 5 (Certification and Infrastructure) CS

Qualification: A qualification/certification in the field of AI&DL for entire schools should be considered. Such AI&DL certifications confirm, for example, that the teaching staff of a school has undergone training in the field of AI&DL.

Motivation
As part of the research, the concept of school certifications emerged, which have already been successfully implemented in some countries (including in the area of digitalization and AI). These certifications were included in the recommendations based on the promising results from various countries and suggestions from the stakeholders.

Overcoming obstacles: The lack of technical infrastructure that can occur in schools and how to deal with this issue should be taken already into account in the teacher trainings.

Motivation
Feedback from teachers repeatedly linked the successful implementation and integration of AI&DL in education to the availability of resources. According to feedback, insufficient technical equipment or lack thereof in schools is a challenge.

6. Policy recommendations for STEAM teachers

The table below shows the revised consolidated policy recommendation for STEAM teachers. The recommendations build on D5.5, Prototype policy and curricula recommendations (STEAM teachers), and D5.6, Review of recommendations (STEAM). Similar to the policy recommendations for CS teachers, the initial recommendations for STEAM teachers are based on a state-of-the-art analysis of relevant policy documents (D1.1 and D1.2) and a series of workshops conducted as part of the TrainDL project. The workshops in the context of WP1 included three national policy building workshops with stakeholders (policy makers and representatives from education institutions from Germany, Austria and Lithuania), reported in D1.3, and one joint international policy building workshop, documented in D1.6.

In the final iteration of this deliverable, the policy recommendations are substantially informed by the findings from WP4 (D4.5, D4.6, and D4.7), as well as the insights regarding interventions in secondary education derived from WP2. Furthermore, the feedback and insights from the final policy dialogue workshop documented in D1.12, were also incorporated into the revised consolidated TrainDL policy recommendations for STEAM teachers.

Policy Recommendation 1 (Focus and Methods) STEAM

Ready-to-use materials: For teachers, in order to support the integration of AI&DL into their teaching, ready-to-use teaching materials developed and tested by qualified experts, as well as tools and courses, that enable a constructionist approach and tailored to the school level, need to be provided.

Motivation

Feedback of STEAM teachers has shown that it is essential to have ready-to-use materials provided. They specifically asked for materials to use in their classes.

Connection of AI&DL to the subjects: It is also essential to emphasize the connection of AI&DL to the teachers' specific subjects to prevent the topics of AI&DL from becoming additional responsibilities. Making the connection between subjects and AI&DL is important, as without background knowledge this may be difficult for a teacher to recognise. In this regard, it is important to provide guidelines for the integration into subjects, complementary to the ready-to-use materials.

Motivation

One of the challenges of integrating AI&DL into the classroom is that teachers do not see the connection of these topics to their subjects. In the feedback on the interventions both CS and STEAM teachers particularly appreciated the content that relates specifically to their subject areas which establish a connection to their specific subjects and therefore facilitate the integration of AI&DL into the timetable.

Contents and Tools: Providing tools and guidance on how to use them and what benefits they can bring to the respective subjects is also of central importance. The content of the teacher training should not focus solely on technical aspects but also on the application of the knowledge as well as risks and opportunities of AI&DL.

Motivation

The teachers in the interventions also asked about concrete steps for integrating the topics of AI&DL into their lessons. For example, websites, tools and computer programs or practical concepts as well as materials or other resources.

Raising awareness: It is important to make teachers aware of the increasing relevance of AI&DL in teacher training, with a particular focus on the importance of these topics in the field of education, so that they can pass this knowledge on to their students in an appropriate way.

Motivation
The feedback from all target groups in all three interventions as well as the input of the stakeholders recognised and mostly highlighted the importance of AI&DL in the different school levels and see the integration into the classroom as the right and necessary step.

Potential benefits: Teacher training courses should highlight the potential advantages of integrating AI&DL not just within classroom lectures but also in further activities. These activities may encompass the creation of teaching materials, brainstorming ideas for class topics, or incorporating AI&DL into lesson planning and administrative tasks for educators.

Motivation
The teachers of the target groups support the integration into the classroom, as the topics and technologies are becoming more and more relevant in today's society. It is therefore important to demonstrate the benefits and applications for teachers outside of the classroom, in addition to the activities and teaching content for students.

Potential risks, ethical aspects & data protection: It is essential that teachers are informed about the potential risks and ethical aspects that the use of AI&DL can entail and also pass this knowledge on to their students. In this context, the topic of data protection should also be part of the teacher training.

Motivation
In addition to the many benefits, the risks must also be highlighted. Stakeholders in the workshops and the research as wells as feedback from the target groups have shown that the risks (e.g. over-automation, data bias, fake news), ethical aspects and data protection aspects must also be taken into account in order to ensure a meaningful and sustainable integration.

Constructivism, unplugged approach: In general, teacher training and the utilization of AI&DL and related tools should prioritize a constructivist, hands-on approach. For teachers and students alike, embracing this method alongside unplugged methodologies as well as acquiring personal experience with AI&DL and its tools proves to be a promising strategy for getting started with, or even delving further into the topic.

Motivation

A playful approach and gamification are recognised approaches to make it easy for the target group of STEAM teachers to get started with AI&DL. The feedback also indicated that even more experimentation and hands-on activities would have been appreciated.

Policy Recommendation 2 (Teacher Training Formats for In-Service Teachers) STEAM

Course formats: There are various options for organising the courses for teacher trainings. In any case, a combination of different course formats should be used. Overall, there is the option of on-site education, online education, hybrid settings, blended-learning or flipped classrooms. Ideally, the courses should take place in a modular setting, i.e. a series of training sessions.

Motivation

The interventions have shown that different and flexible course formats for teacher training are needed in order to meet the needs of the teachers as well as real-life constraints (e.g. available time, requirements of educational authorities, etc.).

Teaching process: The training of teachers should include a combination of on-site courses and online course modules. The courses should include modules to introduce the topics of AI&DL and the general concepts and course content, as well as supplementary course modules to cover specific topics in greater depth. This will optimally complement teacher training and allow teachers to acquire in-depth knowledge of the topics and explore tools and activities independently in the online course formats at their own pace.

Motivation

Stakeholders, teachers and education experts have recommended a modular setting for the teacher training courses, as modular courses allow content to be divided up and dealt with in the best possible way.

Course structure: In order to keep motivation high in the courses, a clear structure should be presented whereas each course unit should have clearly defined learning objectives which teachers will achieve at the end of the unit.

Motivation

Feedback from experts and project partners has emphasized the importance of (learning) objectives for the teacher training in order to clearly define what is to be achieved in the course units.

Feedback mechanisms: Incorporating feedback sessions into teacher training programs, whether in-person or virtual, allows educators to provide constructive feedback on the integration of AI&DL concepts into their actual teaching practices.

Motivation

In bilateral discussions with project partners and as a result of external expert review as well as feedback suggestions from the target groups, the point of feedback mechanisms was included in the recommendations, as regular feedback is important for the successful integration of AI&DL into school education and makes this process easier for teachers.

Policy Recommendation 3 (Education for Pre-Service Teachers) STEAM

The topics of AI&DL should already be included in the training of pre-service teachers at university and should become an integral part of the teacher training curriculum.

Motivation

The interventions have shown that both CS and STEAM teachers see the need and importance of integrating AI&DL subjects and topics into the university programs for future teachers. The teachers in the target groups agree that teachers need to be trained at an early stage in order to impart knowledge about AI&DL to their students. The teachers who were interviewed clearly emphasized the importance of in-service teacher trainings.

Policy Recommendation 4 (Framework Curricula) STEAM

AI&DL subjects should carefully be integrated into framework curricula, as these are already mostly overfilled. It is important to be careful not to risk a loss of interest in AI&DL by further overfilling the compulsory courses. This may require existing content in the curriculum to be reprioritized.

Motivation

In all three countries feedback has shown that the integration of AI&DL subjects and topics into the framework curriculum is necessary. In Austria and Germany in particular, the feedback indicated that the curricula are already tightly packed and that the existing subjects need to be reprioritized in order to integrate new topics/subjects.

Some of the teachers interviewed believe that the successful integration of AI&DL into the framework curriculum is subject to a number of conditions. E.g.: the implementation of the plans in the classroom and the availability of resources. In addition, the teachers interviewed emphasized the already existing workload for teachers.

Policy Recommendation 5 (Certification and Infrastructure) STEAM

Qualification: A qualification/certification in the field of AI&DL for entire schools should be considered. Such AI&DL certifications confirm, for example, that the teaching staff of a school has undergone training in the field of AI&DL.

Motivation

As part of the research, the concept of school certifications emerged, which have already been successfully implemented in some countries (including in the area of digitalization and AI). These certifications were included in the recommendations based on the promising results from various countries and suggestions from the feedback of the target groups.

Overcoming obstacles: The lack of technical infrastructure that can occur in schools and how to deal with this issue should be taken already into account in the teacher trainings.

Motivation

Feedback from teachers repeatedly linked the successful implementation and integration of AI&DL in education to the availability of resources. According to feedback, insufficient technical equipment or lack thereof in schools is a challenge.

7. Policy recommendations for primary school teachers

The table in this section contains the revised consolidated policy recommendations for primary school teachers.

The final policy recommendations are based on the prototype policy and curriculum recommendations (primary school teachers) from D5.7 and the review of the recommendations for primary school teachers from D5.8.

As for the policy recommendations for CS and STEAM teachers, a state-of-the-art analysis of policy documents (WP1) and a series of workshops were used as the basis for formulating the policy recommendations for the primary school level. A total of three national policy building workshops (D1.3) were held with stakeholders, as well as a joint international policy building workshop (D1.6).

In addition to the sources and materials used for D5.7 and D5.8, the adaptations for the final policy recommendations in this deliverable are substantially based on the evaluations in the context of WP4 (D4.6 and D4.7) and the results from WP3, the interventions on primary education. Furthermore, the results from the final policy dialogue workshop, reported in D1.12, have been considered for the revised consolidated TrainDL policy recommendations for primary school teachers.

Policy Recommendation 1 (Focus and Methods) Primary

Ready-to-use materials: Ready-to-use materials are of central importance for incorporating the topics of AI&DL into lessons at primary school level in a meaningful way. Among other things, FAQs with the most frequently asked questions from children and parents can be helpful, as teachers at primary school level usually have little to no knowledge about the topics of AI&DL.

Motivation

Like the other target groups, primary school teachers also gave positive feedback about the developed teaching materials. They emphasized the importance of materials for use in their classes. The research for the policy recommendations has shown that FAQs are a useful mechanism to collect the most central topics and questions.

Connection of AI&DL to the subjects: It is also essential to emphasize the connection of AI&DL to the teachers' specific subjects to prevent the topics of AI&DL from becoming additional responsibilities. Making the connection between subjects and AI&DL is important, as without background knowledge this may be difficult for a teacher to recognise. In this regard, it is important to provide guidelines for the integration into subjects, complementary to the ready-to-use materials.

Raising awareness: Creating awareness should be the main focus when training primary school teachers, as the topic of AI&DL is mostly unfamiliar territory. Therefore, the content should not focus too much on technical aspects but also on the application of the knowledge as well as risks and opportunities of AI&DL.

Potential benefits: To prevent the topic of AI&DL from becoming another additional responsibility in the curriculum, it is important to emphasize the potential benefits. As there is no separate subject for AI&DL at primary school level, the topics need to be incorporated into the curriculum and the regular lessons in a meaningful way. Applications in the organisational context should also be addressed, e.g. using AI for administrative tasks or preparing teaching materials or lesson plans.

Potential risks, ethical aspects & data protection: It is essential that teachers are informed about the potential risks and ethical aspects that the use of AI&DL can entail and also pass this knowledge on to their students. In this context, the topic of data protection should also be part of the teacher training.

Motivation

In addition to the many benefits, the risks must also be highlighted. Stakeholders in the workshops and the research as wells as feedback from the target groups have shown that the risks (e.g. over-automation, data bias, fake news), ethical aspects and data protection aspects must also be taken into account in order to ensure a meaningful and sustainable integration.

Constructivism, unplugged approach: In general, both teacher training and the use of AI&DL and related tools should be based on a playful approach that follows the principles of constructivism. Especially for primary school teachers and students, this playful, hands-on approach combined with unplugged methodologies should be the focus. Teachers as well as students should have the opportunity to try out, play and experiment with AI&DL tools, educational games and learning material in order to gain their own experience.

Motivation

The target group of primary school teachers supported the decision to use an unplugged approach and stated that this approach is suitable and essential for the primary school level. On the other hand, there was the feedback that experimentation and hands-on activities should be even more utilized.

Policy Recommendation 2 (Teacher Training Formats for In-Service Teachers) Primary

Course formats: There are various options for organising the courses for teacher trainings. In any case, a combination of different course formats should be used. Overall, there is the option of on-site education, online education, hybrid settings, blended-learning or flipped classrooms. Ideally, the courses should take place in a modular setting, i.e. a series of training sessions.

Motivation

The interventions have shown that different and flexible course formats for teacher training are needed in order to meet the needs of the teachers as well as real-life constraints (e.g. available time, requirements of educational authorities, etc.).

Teaching process: The training of teachers should include a combination of on-site courses and online course modules. The courses should include modules to introduce the topics of AI&DL and the general concepts and course content, as well as supplementary course modules to cover specific topics in greater depth. This will optimally complement teacher training and allow teachers to acquire in-depth knowledge of the topics and explore tools and activities independently in the online course formats at their own pace.

Motivation
Stakeholders, teachers and education experts have recommended a modular setting for the teacher training courses, as modular courses allow content to be divided up and dealt with in the best possible way.

Course structure: Each course unit should have clearly defined learning objectives. These objectives should be achieved through playful approaches to adequately prepare and empower teachers for the application and transfer of knowledge for their school level.

Motivation
Feedback from experts and project partners has emphasized the importance of (learning) objectives for the teacher training in order to clearly define what is to be achieved in the course units. For primary school teachers in particular, the focus should again be on achieving the objectives using playful approaches, appropriate to the age group of the students.

Feedback mechanisms: Incorporating feedback sessions into teacher training programs, whether in-person or virtual, allows educators to provide constructive feedback on the integration of AI&DL concepts into their actual teaching practices.

Motivation
In bilateral discussions with project partners and as a result of external expert review as well as feedback suggestions from the target groups, the point of feedback mechanisms was included in the recommendations, as regular feedback is important for the successful integration of AI&DL into school education and makes this process easier for teachers.

Policy Recommendation 3 (Education for Pre-Service Teachers) Primary

The topics of AI&DL should already be included in the training of pre-service teachers at university and should become an integral part of the teacher training curriculum.

Motivation

All three target groups agreed on the necessity to integrate AI&DL into the education of pre-service teachers at universities.

Policy Recommendation 4 (Framework Curricula) Primary

AI&DL subjects should carefully be integrated into framework curricula, as these are already mostly overfilled. It is important to be careful not to risk a loss of interest in AI&DL by further overfilling the compulsory courses. This may require existing content in the curriculum to be reprioritized.

Motivation

In all three project countries feedback has shown that the integration of AI&DL subjects and topics into the framework curriculum is necessary. In Austria and Germany in particular, the feedback indicated that the curricula are already tightly packed and that the existing subjects need to be reprioritized in order to integrate new topics/subjects.

Some of the teachers interviewed believe that the successful integration of AI&DL into the framework curriculum is subject to a number of conditions. E.g.: the implementation of the plans in the classroom and the availability of resources. In addition, the teachers interviewed emphasized the already existing workload for teachers.

Policy Recommendation 5 (Certification and Infrastructure) Primary

Qualification: A qualification/certification in the field of AI&DL for entire schools should be considered. Such AI&DL certifications confirm, for example, that the teaching staff of a school has undergone training in the field of AI&DL.

Motivation

As part of the research, the concept of school certifications emerged, which have already been successfully implemented in some countries (including in the area of digitalization and AI). These certifications were included in the recommendations based on the promising results from various countries and suggestions from the feedback of the target groups.

Overcoming obstacles: The lack of technical infrastructure that can occur in schools and how to deal with this issue should be taken already into account in the teacher trainings.

Motivation

Feedback from teachers repeatedly linked the successful implementation and integration of AI&DL in education to the availability of resources. According to feedback, insufficient technical equipment or lack thereof in schools is a challenge.

Policy Recommendation 6 (Involvement of Parents) Primary

Parent involvement: At primary school level, parents might actively be involved as well: Teachers should be enabled to create awareness among parents and to emphasize the importance and implications of AI&DL.

Motivation

Research on the recommendation in the context of primary schools and integration of AI&DL has shown that involving parents and getting them on board is a relevant factor for this age group in particular.

8. Conclusion and Outlook

This final deliverable of TrainDL policy recommendations for CS, STEAM and primary education concludes the project's work on policy recommendations. Through the iterations of policy experimentation, the recommendations evolved considerable to this final set, considering stakeholder input in each iteration. In the final iteration of this deliverable, the policy recommendations are substantially informed by the findings from WP4 (evaluation of interventions) as well as the insights regarding interventions conducted as part of WP2&3.

For this final set of recommendations, we have also included the motivation as to why each aspect of the recommendations was included, clearly linking each aspect of the recommendations to a result of policy experimentation. Stakeholder input was concluded through the final policy dialogue workshop (reported in D1.12) in which overwhelmingly positive feedback was received.

One of the core topics of the final policy dialogue workshop was the long-term sustainability of the TrainDL project in general, and the policy recommendations in particular. While the project and associated funding ends, the project results need to live on. The stakeholders participating in the workshop were asked to provide input on potential dissemination activities that would be effective in this context, and valuable feedback was received.

The project partners will continue disseminate and operationalise the recommendations at different levels (from how AI&DL education is considered at the political level, down to how to implement AI&DL education in curricula and schools), starting by continuing to work with the relevant stakeholders that were part of this project in the partner countries of Germany, Austria and Lithuania (as well as interested stakeholders beyond that). Already existing relations between the projects research partners and stakeholders from the education sector have been strengthened through the project, and are surely the best opportunity for short-term to mid-term dissemination and operationalisation of TrainDL policy recommendations.

Further suggestions for dissemination and operationalisation of the recommendations given by the stakeholders of the final policy dialogue workshop include fostering collaborations with relevant institutions, programs and authorities (on national, EU and global level), considering additional marketing activities to promote the TrainDL project including the recommendations, or to organise/participate in competitions to get in contact with the target group of pre-service/in-service teachers (including relevant teacher education institutions). The TrainDL project will assess those opportunities and continue to find ways to actively disseminate and operationalise the results.

Annex 1 – Overview Table of TrainDL Policy Recommendations for CS, STEAM and Primary

Policy Recommendation 1 (Focus and Methods)	CS	STEAM	Primary
Ready-to-use materials: For teachers, in order to support the integration of AI&DL into their teaching, ready-to-use teaching materials developed and tested by qualified experts, as well as tools and courses, that enable a constructionist approach and tailored to the school level, need to be provided.	✔	✔	
Ready-to-use materials (primary): Ready-to-use materials are of central importance for incorporating the topics of AI&DL into lessons at primary school level in a meaningful way. Among other things, FAQs with the most frequently asked questions from children and parents can be helpful, as teachers at primary school level usually have little to no knowledge about the topics of AI&DL.			✔
Connection of AI&DL to the subjects: It is also essential to emphasize the connection of AI&DL to the teachers' specific subjects to prevent the topics of AI&DL from becoming additional responsibilities. Making the connection between subjects and AI&DL is important, as without background knowledge this may be difficult for a teacher to recognise. In this regard, it is important to provide guidelines for the integration into subjects, complementary to the ready-to-use materials.	✔	✔	✔
Contents and Tools: Providing tools and guidance on how to use them and what benefits they can bring to the respective subjects is also of central importance. The content of the teacher trainings should not focus solely on technical aspects but also on the application of the knowledge as well as risks and opportunities of AI&DL.	✔	✔	
Raising awareness: It is important to make teachers aware of the increasing relevance of AI&DL in teacher training, with a particular focus on the importance of these topics in the field of education, so that they can pass this knowledge on to their students in an appropriate way.	✔	✔	
Raising awareness (primary): Creating awareness should be the main focus when training primary school teachers, as the topic of AI&DL is mostly unfamiliar territory. Therefore, the content should not focus too much on technical aspects but also on the application of the knowledge as well as risks and opportunities of AI&DL.			✔
Potential benefits: Teacher training courses should highlight the potential advantages of integrating AI&DL not just within classroom lectures but also in further activities. These activities may encompass the creation of teaching materials, brainstorming ideas for class topics, or incorporating AI&DL into lesson planning and administrative tasks for educators.	✔	✔	
Potential benefits (primary): To prevent the topic of AI&DL from becoming another additional responsibility in the curriculum, it is important to emphasize the potential benefits. As there is no separate subject for AI&DL at primary school level, the topics need to be incorporated into the curriculum and the regular lessons in a meaningful way. Applications in the organisational context should also be addressed, e.g. using AI for administrative tasks or preparing teaching materials or lesson plans.			✔

	CS	STEAM	Primary
Potential risks, ethical aspects & data protection: It is essential that teachers are informed about the potential risks and ethical aspects that the use of AI&DL can entail and also pass this knowledge on to their students. In this context, the topic of data protection should also be part of the teacher training.	✓	✓	✓
Constructivism, unplugged approach: In general, teacher training and the utilization of AI&DL and related tools should prioritize a constructivist, hands-on approach. For teachers and students alike, embracing this method alongside unplugged methodologies as well as acquiring personal experience with AI&DL and its tools proves to be a promising strategy for getting started with, or even delving further into the topic	✓	✓	
Constructivism, unplugged approach (primary): In general, both teacher training and the use of AI&DL and related tools should be based on a playful approach that follows the principles of constructivism. Especially for primary school teachers and students, this playful, hands-on approach combined with unplugged methodologies should be the focus. Teachers as well as students should have the opportunity to try out, play and experiment with AI&DL tools, educational games and learning material in order to gain their own experience.			✓
Self-assessment test: In order for in-service CS teachers to know what objective knowledge about AI&DL they already have or in which areas they need to improve, a self-assessment test of their factual AI&DL knowledge is recommended.	✓		

Policy Recommendation 2 (Teacher Training Formats for In-Service Teachers)	CS	STEAM	Primary
Course formats: There are various options for organising the courses for teacher trainings. In any case, a combination of different course formats should be used. Overall, there is the option of on-site education, online education, hybrid settings, blended-learning or flipped classrooms. Ideally, the courses should take place in a modular setting, i.e. a series of training sessions.	✓	✓	✓
Teaching process: The training of teachers should include a combination of on-site courses and online course modules. The courses should include modules to introduce the topics of AI&DL and the general concepts and course content, as well as supplementary course modules to cover specific topics in greater depth. This will optimally complement teacher training and allow teachers to acquire in-depth knowledge of the topics and explore tools and activities independently in the online course formats at their own pace.	✓	✓	✓
Course structure: In order to keep motivation high in the courses, a clear structure should be presented whereas each course unit should have clearly defined learning objectives which teachers will achieve at the end of the unit.	✓	✓	
Course structure (primary): Each course unit should have clearly defined learning objectives. These objectives should be achieved through playful approaches to adequately prepare and empower teachers for the application and transfer of knowledge for their school level.			✓
Feedback mechanisms: Incorporating feedback sessions into teacher training programs, whether in-person or virtual, allows educators to provide constructive feedback on the integration of AI&DL concepts into their actual teaching practices.	✓	✓	✓

Policy Recommendation 3 (Education for Pre-Service Teachers)	CS	STEAM	Primary
The topics of AI&DL should already be included in the training of pre-service teachers at university and should become an integral part of the teacher training curriculum.	✓	✓	✓

Policy Recommendation 4 (Framework Curricula)	CS	STEAM	Primary
AI&DL subjects should carefully be integrated into framework curricula, as these are already mostly overfilled. It is important to be careful not to risk a loss of interest in AI&DL by further overfilling the compulsory courses. This may require existing content in the curriculum to be reprioritized.	✓	✓	✓

Policy Recommendation 5 (Certification and Infrastructure)	CS	STEAM	Primary
Qualification: A qualification/certification in the field of AI&DL for entire schools should be considered. Such AI&DL certifications confirm, for example, that the teaching staff of a school has undergone training in the field of AI&DL.	✓	✓	✓
Overcoming obstacles: The lack of technical infrastructure that can occur in schools and how to deal with this issue should be taken already into account in the teacher trainings.	✓	✓	✓

Policy Recommendation 6 (Involvement of Parents)	CS	STEAM	Primary
At primary school level, parents might actively be involved as well: Teachers should be enabled to create awareness among parents and to emphasize the importance and implications of AI&DL.			✓