2.11. Final experience report

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Recapitulation of the three intervention rounds

Technologies based on artificial intelligence (AI) are increasingly part of our lives. We interact with AI-based technologies, we share our data with these technologies, and we consume products created by these technologies. To enable citizens of today and tomorrow to understand, responsibly use and shape AI, education about AI and data should start in schools. This requires school teachers to be the ones who acquire AI and data literacy and transfer this knowledge to students. To better understand how to implement AI and data literacy in teacher education and professional development, and to provide policy recommendations for the implementation of AI and data literacy in teacher education and K-12 education, the TrainDL project iteratively developed and delivered teacher training in three European countries: Austria, Germany, and Lithuania.

The project consisted of three rounds of interventions. In the first round of interventions, reported in Deliverable D2.3, we conducted seven trainings with secondary computer science (CS) teachers. In the second round of interventions, reported in Deliverable D2.6, we expanded the scope to include secondary CS and STEAM (Science, Technology, Engineering, the Arts, and Mathematics) teachers and conducted three national trainings, one with CS teachers and two with STEAM teachers. In this third round of interventions, we refined the concepts for the teacher trainings based on the results of the evaluation, policy recommendations, and further research on AI and data literacy, and opened the trainings to all secondary school teachers – CS teachers, STEAM teachers, humanities, language and sport teachers. We also developed a new format for the 2.5-day training for these teachers. In total, we conducted 7 training sessions and one semester-long university seminar during the third round of interventions. We reported on the third round of interventions in Deliverable 2.9. A total of 196 CS and 139 STEAM teachers participated in the workshops during the 3 rounds of interventions. The following list outlines the dates, cities, and audiences of the trainings during all three rounds of intervention:

First round of interventions:
13.06.2022 | Berlin | Pre- and In-Service Teachers
20.09.2022 | Berlin | In-Service Teachers
29.09.2022 | Vienna | In-Service Teachers
02. – 03.11.2022 | Berlin | Pre-Service Teachers
25. – 27.11.2022 | Heidelberg | In-Service Teachers
10.12.2022 | Vilnius | In-Service Teachers
31.01.2023 | Vienna | In-Service Teachers

Second round of interventions:
09.03.2023 | Berlin, Germany | In-Service CS Teachers (2 groups)
17.05.2023 | Graz, Austria | In-Service STEAM Teachers

26.05.2023 | Vilnius, Lithuania | In-Service STEAM Teachers

Third round of interventions:
25.04. - 18.07.2023 | Berlin | CS pre-service teachers
23.08.2023 | Düsseldorf | Secondary school teacher-trainers
18.09.2023 | Berlin | In-service CS teachers
18.10.2023 | Berlin | Secondary school teacher-trainers
23.10.2023 | Austria | In-service secondary school teachers
24. – 26.11.2023 | Zeitz | In-service CS teachers
09.01.2024 | Vilnius | In-service secondary school teachers
26. – 28.01.2024 | Meißen | In-service secondary school teachers

All training sessions were practice-oriented and focused on activities that could be used in the classroom to enable teachers to apply what they had learned directly in their classrooms. In this way, the teachers received the appropriate pedagogical knowledge at the same time as the content knowledge, which we based on the Dagstuhl Triangle framework.

In what follows, we recapitulate the general pedagogical approach, provide a summary of the learning materials we used in the three rounds of interventions, and summarize the challenging and best practice experiences we had in designing and implementing the training sessions.

Summary of the pedagogical concept

For all workshops, our didactical concept consisted of two components: (1) content knowledge (based on the Dagstuhl triangle framework [2]) and (2) pedagogical knowledge.

In terms of content knowledge, we focused on fundamental paradigms of rule-based AI, supervised, unsupervised and reinforcement learning (AI-related content) and the data lifecycle (DL-related content), as these are recurring themes in international AI & DL frameworks[5, 6]. Following the Dagstuhl triangle, all topics are covered from three perspectives: structural perspective (How and why does that work?), socio-cultural perspective (How and why does it affect?) and application-oriented perspective (How and when to use what?), as shown in Figure 1. In all workshops, we deeply focus on structural perspective, as it is a foundation for socio-cultural and application-oriented perspectives. It is not possible to assess technology without having factual knowledge.

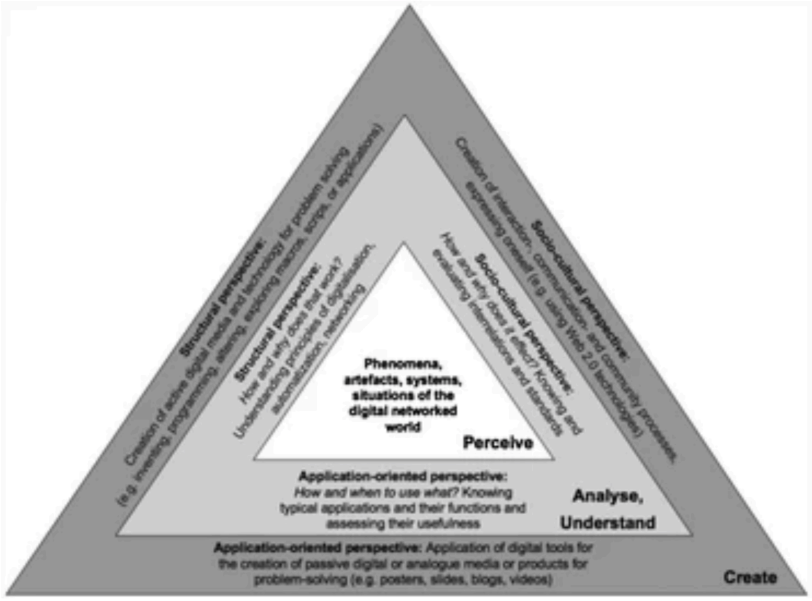

Figure 1: Three perspectives of the Dagstuhl triangle [2].

Additionally, expert presentations enriched our workshops by deepening teachers' machine learning content knowledge, addressing societal impacts, and answering participant queries.

For the pedagogical knowledge, we based the training on the "didactic biplane"-approach which is commonly used for CS teacher training[11]. In this method, the participating teachers take on the role of students, while the workshop trainer takes on the role of the teacher. In this way, teachers experience a classroom-lesson from the students' perspective. Our pedagogical suggestion for the classroom combines unplugged activities with plugged activities, enhancing methodological diversity. Unplugged methods offer the benefit of a concept focus, while in a plugged setting students engage in creating digital artefacts such as Orange3 workflows or training computer vision systems. With this, we ensure pedagogical content knowledge through classroom-ready activities, allowing teachers to effectively impart complex concepts. In the third round of interventions, we also introduced teachers to the topic of chatbots following all three perspectives of the Dagstuhl triangle. We also gave teachers an opportunity to share their experiences in utilising AI chatbots in their disciplines, fostering a productive exchange.

[1] Viktoriya Olari, Till Zoppke, Martin Reger, Evgenia Samoilova, Martin Kandlhofer, Valentina Dagiene, Ralf Romeike, Anna Sarah Lieckfeld, and Ulrike Lucke. 2024. Introduction of Artificial Intelligence Literacy and Data Literacy in Computer Science Teacher Education. In Proceedings of the 23rd Koli Calling International Conference on Computing Education Research (Koli Calling '23). Association for Computing Machinery, New York, NY, USA, Article 47, 1–2. https://doi.org/10.1145/3631802.3631851
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[6] Tilman Michaeli, Ralf Romeike, and Stefan Seegerer. 2023. What Students Can Learn About Artificial Intelligence - Recommendations for K-12 Computing Education. In Towards a Collaborative Society Through Creative Learning, Therese Keane, Cathy Lewin, Torsten Brinda, and Rosa Bottino (Eds.). Springer Nature Switzerland, Cham, 196–208. https://doi.org/10.1007/978-3-031-43393-1_19
[7] Tilman Michaeli, Stefan Seegerer, and Ralf Romeike. 2022. Modul KI-B3: Schlag den Roboter und Modul KI-B4: Von Daten und Bäumen, Reihe IT2School - Gemeinsam IT entdecken. https://www.wissensfabrik.de/it2school/. Accessed: 2023-06-23.
[11] Diethelm Wahl. 2013. Lernumgebungen erfolgreich gestalten: vom trägen Wissen zum kompetenten Handeln (Successfully designing learning environments: from inert knowledge to competent action) (3. Auflage mit Methodensammlung ed.). Verlag Julius Klinkhardt, Bad Heilbrunn.

Summary of the learning materials

In the first round of interventions, we used research-based open source learning materials for machine learning and rule-based AI [7]. In the second and third rounds, we continued to use these materials and gradually developed new unplugged and plugged activities. We accompanied the new materials with Expectation Horizon, so that teachers could try out the materials directly with students.

Following a suggestion from teachers in the second round of interventions, we provide below an overview of the activities used in the interventions for secondary school teachers in the TrainDL project. Non-specific activities such as introductory rounds, feedback and evaluation are omitted. The table includes suggestions for the classroom grade level, in which it can be used. For activities that were designed for the workshops only and were not intended to be used with students, we indicate that it is not a classroom activity.

[7] Tilman Michaeli, Stefan Seegerer, and Ralf Romeike. 2022. Modul KI-B3: Schlag den Roboter und Modul KI-B4: Von Daten und Bäumen, Reihe IT2School - Gemeinsam IT entdecken. https://www.wissensfabrik.de/it2school/. Accessed: 2023-06-23.

ID	Activity	Topic	Classroom Grade Level	Prerequisites	Description	Learning objective	Social form	time	Material	Required tools & software	Status	Intervention (Place/Date)	online resources
act_01	AI Quiz (Slides)	AI in everyday life	9+	none	The teacher shows a deck of slides. Each slide displays an AI application from real life. For each slide, the teacher asks the students to raise their hands if they think the displayed application is an AI application.	... gain an overview on AI applications. ... increase awareness of AI technologies in everyday live.	Plenary	10'	Slides	PC, Projector	Published by Wissensfabrik in 2021	Berlin 13.06.2021 Berlin 20.09.2022 Wien 29.09.2022 Berlin 02.11.2022 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Vienna 31.01.2023 Graz 17.05.2023 Vilnius 25.05.2023	

ID	Activity	Topic	Classroom Grade Level	Prerequisites	Description	Learning objective	Social form	time	Material	Required tools & software	Status	Intervention (Place/Date)	online resources
act_02	Introduction to AI	AI basic concepts	Not a classroom activity	none	The trainer presents basic AI concepts like strong vs. weak AI, principles like Deep Learning, definitions, AI history, AI subdisciplines etc.	... participants have an overview over the field of AI	presentation	10'	slides	PC, projector	Published for participants	Berlin 13.06.2021 Berlin 20.09.2022 Wien 29.09.2022 Berlin 2.11.2022 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Vienna 31.01.2023 Graz 17.05.2023 Vilnius 25.05.2023 Düsseldorf 23.08.2023 Berlin 05.09.2023 Berlin 18.09.2023 Zeitz 24.11.2023 Meißen 26.01.2024	
act_03	Beat the robot	Classical AI and reinforcement learning	9+	none	Unplugged exercise. The students play hexapawn, a reduced variant of chess, against each other. They define the best move for black in a series of positions as an example for a classical AI. Then they train an AI by reinforcement learning that gradually perfects itself in each game.	... define a classical AI ... train a game playing agent via reinforcement learning.	pairs	45'	Wissensfabrik KI-B3 (worksheets, game boards, pawns), coloured stones	none	published	Berlin 13.06.2021 Berlin 20.09.2022 Wien 29.09.2022 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Vienna 31.01.2023 Düsseldorf 23.08.2023	https://www.wissensfabrik.de/produkt/modul-ki-b3-schlag-den-roboter/
act_04	Prototype customer	Unsupervised Learning	9+	none	The students put three coins on a coordinate system that represents customer profiles. One axis shows the average total purchase, the other the number of purchases of a certain customer. Then they uncover, one by one, cards of individual customer profiles and adjust the positions of their coins so that they best cover customer profiles. Finally they compare their results with an optimal solution and reflect on their strategy.	... replay a clustering algorithm ... explain the principle of unsupervised learning ... reflect on data protection	Groups of 2-4	30'	Wissensfabrik KI-B3 (Manual, coordinate systems, cards, model solution)	none	published	Berlin 13.06.2021 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Wien 31.01.2023	https://www.wissensfabrik.de/produkt/modul-ki-b3-schlag-den-roboter/

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act_05	Biting and non-biting monkeys (unplugged)	Decision Trees, Supervised learning	9+	none	Unplugged exercise. The students define a decision tree that predicts if a monkey bites or doesn't bite, based on its appearance. Then they set up a confusion matrix and evaluate the accuracy of their model.	... define a decision tree ... differentiate between training and test data ... assess the practical consequences of prediction errors. ... explain the principle of supervised learning	Individual work	30'	Wissensfabrik KI-B4 (Slides, 1 worksheet per student)	none	published	Berlin 13.06.2021 Berlin 20.09.2022 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Vienna 31.01.2023 Zeitz 24.11.2023	https://www.wissensfabrik.de/produkt/modul-ki-b4-von-daten-und-baeumen/
act_06	Introduction to data lifecycle	Data Lifecycle	Not a classroom activity	none	The trainer introduces the concept of the data lifecycle and describes the objectives and typical activities of each phase	participants are oriented and prepared for a eventallyl following data project.	presentation	10'	slides	PC, projector	Published for participants	Berlin 13.06.2021 Berlin 20.09.2022 Heidelberg 25.11.2022 Druskininkai 31.01.2023 Zeitz 24.11.2023	
act_07	Biting and non-biting monkeys (Orange3)	Data workflows in Orange3	9+	Basic command of English	The students digitise the data from the unplugged exercise (samples of biting and non-biting monkeys) and then design a data-workflow for training and testing a prediction model in Orange3.	... digitise a data set ... design a data-workflow in Orange3 ... evaluate the quality of the model	Individual work	30'	Wissensfabrik KI-B4 (worksheets, data set of monkeys in CSV format)	Student PCs with Orange 3	published	Berlin 13.06.2021 Berlin 20.09.2022 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Vienna 31.01.2023 Graz 26.05.2023 Vilnius 26.05.2023	https://www.wissensfabrik.de/produkt/modul-ki-b4-von-daten-und-baeumen/
act_08	Portugues e Students	Data analysis and workflows in Orange3	10+	Basic command of English	The participants analyse an anonymised data set with demographic data of Portuguese students and their success in school. They train a model that predicts a student's success and determine the most important factors influencing their success. Finally, there is a discussion about which data can be collected from learners and how it can be processed, and about ethical aspects of automated decision-making systems.	... conduct a data analysis in Orange3 ... determine high impact factors on school success. ... discuss ethical aspects of automated decision-making systems	Individual work	45'	Wissensfabrik KI-B4 (worksheets, help cards, data sets)	Student PCs with Orange 3	published	Berlin 13.06.2021 Berlin 20.09.2022 Heidelberg 25.11.2022 Druskininkai 10.12.2022 Vienna 31.01.2023	https://www.wissensfabrik.de/produkt/modul-ki-b4-von-daten-und-baeumen/
act_09	AI technologies	AI technologies in Business	Not a classroom activity	none	The participants form groups of three and explore a database of AI business ideas and projects. They pick a favorite project and analyse, which technology it uses, how people interact with the AI system and how it affects society. They then present their results to the other participants.	... have an overview of current developments in the field of AI ... analyse an AI project according to the three perspectives of the Dagstuhl triangle	Group work, participant presentation	45'	slides	PCs with Internet access and a web-browser, projector	Shared among participants	Berlin 2.11.2022	https://www.plattform-lernende-systeme.de/ki-landkarte.html

ID	Activity	Topic	Classroom Grade Level	Prerequisites	Description	Learning objective	Social form	time	Material	Required tools & software	Status	Intervention (Place/Date)	online resources
act_10	Oil Production	Data project	11+	Basic Python skills	The students conduct a data analysis and identify correlations between oil consumption, price and GDP per capita. They are guided by a case based on a Jupyter notebook.	... conduct a case study ... experience how a data-scientist works ... explain how a correlation differs from cause and effect ... know basic types of data visualization.	Individual work or pairs	45'	Case study as a Jupyter notebook (digital)	Student PCs with internet connection or locally installed software stack	Published for participants	Heidelberg 25.11.2022	
act_11	I AM AI	Data project	Not a classroom activity	none	Participants take on the role of data scientists and are tasked with improving the marketing of the exhibition "I AM AI", to which an excursion will take place as part of the workshop. The participants design surveys that are completed by all participants and collect data (photos, position data, steps counter) with their digital devices during the excursion. The data acquired will be cleaned and shared among the participants. Groups then work on the data analysis, create visualisations and develop suggestions for improving marketing. The results are shared in the plenary session.	... conduct a data project following the data lifecycle ... plan and conduct a survey ... experience real-world problems with data ... analyse data with traditional statistics and machine learning to analyse data ... visualise and present findings from a data analysis	Individual work, group work, participant presentation	300'	Slides	PC, projector Digital devices for data collection	Shared among participants	Heidelberg 25.11.2022	
act_12	Expert presentation	Depends on expert	Not a classroom activity	none	An AI or Data Literacy expert presents his or her work, research projects, including scientific background, and takes the audience's questions.	... receive an in-depth view in an AI or Data Literacy practice. ... expand their expertise in AI and data literacy.	Presentation, plenary discussion	60'	slides	PC, projector	Published for participants	Heidelberg 25.11.2022 Zeitz 24.11.2023 Meißen 26.01.2024	https://box.fu-berlin.de/s/QW4FoACMQ8twKgT
act_13	Open Space	Depends on participants	Not a classroom activity	Individual participants are willing to share projects	Individual participants share their teaching activities or projects from the area of AI and Data Literacy education.	... participants share their teaching experiences.	Presentation, plenary	depends	slides	PC, projector	Shared among participants	Heidelberg 25.11.2022 Zeitz 24.11.2023 Meißen 26.01.2024	
act_14	Development of a lesson series	Pedagogical Content knowledge	Not a classroom activity	none	The teachers form groups and develop lesson series on AI and Data Literacy topics, based on the activities they have completed before. They prepare a short presentation and finally share their results with the other participants.	... reflect what they have learned in the previous activities ... make the first step towards incorporating AI and data into their teaching practice.	Group work	90'	Worksheet or slide with assignment	PC, projector	unpublished	Heidelberg 25.11.2022 Zeitz 24.11.2023 Meißen 26.01.2024	https://box.fu-berlin.de/s/QW4FoACMQ8twKgT

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act_15	Introduction to generative AI	Generative AI, LLMs	Not a classroom activity	none	The trainer introduces the concept of generative AI and places it in the context of other ML technologies.	Participants know the importance of generative AI and are motivated for the following exercise	presentation	15'	slides	PC, projector	Published for participants	Berlin 09.03.2023 Berlin 18.10.2023	
act_16	Grimm's new Fairy tales	Language models	9+	none	Unplugged exercise. The students train a simple language model (Markov chain) based on first sentences of Grimm tales. They then collaborate on generating new sentences. The worksheet also contains tasks for reflection. Finally generated sentences are shared in the plenary. For consolidation a cloze exercise exists.	... training a language model by reading in word sequences (K1), ... the role of chance in generating new sentences (K2), ... training and application as different phases in the life cycle of a language model (K3), ... the influence of the text corpus on the generated sentences (K4).	Individual, groups of 3-4, plenary	30'	A set for 4 students contains ... ... 4 worksheets ... 4 different model graphs ... 8 sentences	none	Published for participants	Berlin 09.03.2023 Berlin 16.05.2023 (Seminar FUB) Graz 17.05.2023 Vilnius 26.05.2023 Düsseldorf 23.08.2023 Berlin 18.10.2023 Zeitz 24.11.2023 Meißen 26.01.2024	https://nextcloud.gi.de/s/rr8NFQCiSjWaaTo
act_17	Ethical Case studies	AI ethics	7-10	none	The students read a case study (either individually or in the plenary) and then reflect and discuss the story. This activity can be done well as a "think pair share".	Students know examples of algorithmic bias and know which data an AI chatbot is trained with.	Think-pair-share	15' per story	1 worksheet per students	none	unpublished	Berlin 09.03.2023	
act_18	Iris Flowers	Classification, Introduction to Orange3	Not a classroom activity	none	Self-Learning materials for introduction into Orange3 and to set up a basic data workflow, using the canonical Iris flower data set.	Teachers use Orange3 to set up a basic data workflow.	Individual work	30'	1 worksheet per participant	PCs with Orange3	unpublished	Graz 17.05.2023 Vilnius 26.05.2023	
act_19	Malaria	Image classification	9+	none	The students train an image classification system based on "Teachable Machine" to detect infected blood cells. Then they test their model and compute its accuracy by filling out a confusion matrix. Finally they reflect on the results and can optionally integrate the model in an application by implementing a Scratch App	Students... ... explain the purpose of training and test data when creating a classification model. ... train a classification model to answer a domain-specific question. ... evaluate the photographic artefacts for their influence on the quality of the model. ... test the classification model using the test data provided. ... use the model to answer a subject-specific question.	individual/ as pairs	45'	1 worksheet per student	PCs with a Web-Browser, Internet	Published for participants	Graz 17.05.2023 Vilnius 26.05.2023 Berlin 18.09.2023 Zeitz 24.11.2023	

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act_20	AI Quiz (cards)	Definition of AI, AI applications	10+	none	The teacher hands out sets of 10 cards to groups of 2-4 people. Each card depicts an application or system that uses AI or might be viewed by people as an AI application. The students then sort the cards from “fewer AI” to “more AI”. Alternatively the students fill out a template in which they write down features that make the displayed application an AI application. The results are then shared in plenary, or the teacher shows a slide deck and recalls AI features and definitions.	Students have an overview on AI applications, students know features of AI	Group work (2-4 people), then plenary	30’	1 Set of Quiz cards per group, 1 template per group, Slides	PC, Projector	Unpublished (current version uses unlicensed images)	Berlin 23.08.2023 Berlin 18.09.2023 Meißen 26.01.2024	
act_21	Statistics unplugged	Data acquisition	5+	none	Also known as “Human Barometer”. The teacher asks the students to position themselves in a line as their answer to a question. For example how long they need to come to school (in minutes), if they like ice cream etc. Once they find their position, the teacher then asks individual students to comment or to explain their answer. Later, the teacher can refer to the survey and address various aspects like data types (integer, bool) or personal data.	Students are activated. Ideal for a learning group that does not know each other before	Plenary	10’ - 20’	List of questions	Free Space in a room, corridor or outside	unpublished	Düsseldorf 23.08.2023 Zeitz 24.11.2023 Meißen 26.01.2024	
act_22	AI chatbots at school	AI application knowledge	Not a classroom activity	Initial experience in the use of AI chatbots	The participants get together in groups, for example according to their teaching subjects, and discuss how they use ChatGPT or comparable chatbots professionally. They write use cases or prompts on moderation cards and present these to everyone in a subsequent plenary phase. Finally, there is a phase in which participants can try out prompts on their own or in groups. Further material, such as a prompt catalogue, is made available to them for inspiration.	… are informed about which professional tasks can and which can not be performed by AI chatbots. … are confident in using AI chatbots and in supporting their colleagues.	Group work, participant presentations, individual work	60’	Worksheet or slide with assignment, supporting materials such as a prompt-cookbook, a prompt-catalogue or a scorecard of AI-Chatbots	Moderation cards, pens, a pinboard, PCs with internet access	unpublished	Düsseldorf 23.08.2023 Meißen 26.01.2024	https://box.fu-berlin.de/s/QW4FoACMQ8twKgT https://box.fu-berlin.de/s/cHNrXLDQFoDoBBC
act_23	AI and Music	AI and Music	7+	none	The students try out three different AI music applications in which AI takes the role of a co-creator. In ‘AI duett’ it jams with the user in a live session, in ‘Bach doodle’ it composes a four-voice choral based on the user’s melody and in ‘AI opera’ it generates polyphonic harmonies based on a keynote specified by the user.	… get creative with AI. … learn musical concepts.	Learning station, Individual or group work	15’	1 worksheet per student	Student PCs	Published for participants	Düsseldorf 23.08.2023	https://box.fu-berlin.de/s/cHNrXLDQFoDoBBC

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act_24	Material recognition	Image classification	9+	none	The students train an image classification model for a sorting robot that can identify different materials. They use a camera and real-world objects to create images as their training data. The model is implemented with Teachable Machine. The students test their model and compute its accuracy. Optionally the model can be integrated in a scratch program.	... create sample images as training data ... train an image classification ... test an image classification ... calculate the model accuracy	Individual work or pairs	30'	1 worksheet per student, bags with materials (e.g. pebbles, pieces of wood, leaves),	Student PCs with internet connection, web browser with teachable machine, cameras	Published for participants	Düsseldorf 23.08.2023 Berlin18.09.2023	https://box.fu-berlin.de/s/j2EQngpNXA2xj3e
act_25	Abalone	Multiple linear regression	10+	Linear functions (math)	The teacher explains simple linear regression with a set of slides or on the board. Next, the teacher demonstrates how to load a dataset and set up a basic data workflow with Orange3. Then the students get a worksheet that guides them to create a data workflow to predict the age of an abalone based on measurable features.	... conduct exploratory data analysis ... create an application using multiple linear regression ... explain the results of the multiple linear regression ... calculate the model accuracy	Plenary, then Individual work	45'	slides 1 worksheet per student	PC with Orange3, Projector, Whiteboard (optional), Student PCs with Orange3	Published for participants	Berlin 05.09.2023 Berlin 18.09.2023 Zeitz 24.11.2023 Meißen 26.01.2024	https://nextcloud.gi.de/s/rr8NFQCiSjWaaTo
act_26	Supercodingball	Intelligent agents	9+	Basic block-based programming skills	The students implement intelligent agents that compete in a simulated soccer match, guided by a worksheet.	... explain the concept of intelligent agents. ... implement a classical game-playing AI ... deepen their programming skills	Individual work / pairs	45'	1 worksheet per student	Student PCs with a web browser and internet access	Published for participants	Berlin 18.09.2023	https://box.fu-berlin.de/s/j2EQngpNXA2xj3e
act_27	Food quality control	Algorithmic bias	9+	none	The students train a computer vision model that classifies food (bananas, tomatoes or apples) as fresh or rotten. They test the model and discover misclassifications. The students then are asked to check the training data	Students know causes for algorithmic bias	Individual work	45'	1 worksheet per student	PCs, Internet, Smartphones, Image data sets (online), bananas (optional)	Published for participants	Zeitz 24.11.2023 Meißen 26.01.2024	https://nextcloud.gi.de/s/rr8NFQCiSjWaaTo
act_28	Generative Cocktail Producer (GCP)	Knowledge based systems	9+	none	Unplugged exercise. The students create a knowledge graph from a collection of mocktail (non-alcoholic cocktail) recipes. They are guided by a worksheet following a systematic approach according to the data lifecycle: goal definition, data acquisition, data exploration, formalising the data, retrieval & inference, and finally evaluation.	... formulate a goal for a data project ... process and record data from individual recipes in a tabular format ... collaboratively create a knowledge base ... generate new recipes by retrieval & inference	Groups of 3 people	30'	20 different cocktail recipes (laminated), 1 worksheet per student, 1 graph for 3 students	none	Published for participants	Zeitz 24.11.2023	https://box.fu-berlin.de/s/TWBKXzaMqGX2Y2o?path=%2F00_GCP_Generative_Cocktail_Producer_Unplugged

ID	Activity	Topic	Classroom Grade Level	Prerequisites	Description	Learning objective	Social form	time	Material	Required tools & software	Status	Intervention (Place/Date)	online resources
act_29	Pizza Price prediction	Data lifecycle, data project	11+	Basic software engineering skills	Data project. The students form teams that each want to open a new pizza restaurant. They collect the menus from local pizza restaurants (as part of an excursion, alternatively from via the internet) and organise the data in a table. They analyse the data and determine average pizza prices. Using streamlit.io they implement an app for a pizza price prediction based on ingredients.	... collaborate and set goals in a team ... acquire data and organise it in a spreadsheet ... analyse and describe the dataset ... implement a price prediction app	Groups of 3-4	180'	slides	Google spreadsheet streamlit.io	Published for participants, not fully elaborated	Zeitz 24.11.2023	https://box.fu-berlin.de/s/TWBKXzaMqGX2Y2o?path=%2F04_Datenwerkstatt_The_best_pizza_in_town_Orange_JupiterNotebook_Streamlit
act_30	Prompt Battle	AI Image generation	5+	none	Participants generate images using DALL-E, stablediffusion or a similar generative AI tool. A theme is given for the images, or the participants have to try to reproduce a given image as best as possible. There is applause or a prize for the best picture	... get creative with AI. ... learn prompting techniques for image generation	Plenary, individual or group work	10'	A given theme or image	Student PCs with access to an image generator	not fully elaborated	Zeitz 24.11.2023	
act_31	AI-Pack	AI teaching competences	Not a classroom activity	none	The trainer introduces the AI competence model AI-Pack. Then groups according to the teacher's subjects are formed, in which they discuss and find subject-specific examples for the different competence types. Finally the groups share their findings with everybody.	...know the many ways in which AI influences everyday school and classroom life. ... reflect on areas in which they can continue their training in AI or improve their teaching.	presentation Group work	60'	Presentation slides, worksheets with the competence model	PC, projector	AI-Pack research paper published	Meißen 28.01.2024	https://box.fu-berlin.de/s/QW4FoACMQ8twKgT

Summary of the challenging and best practice experiences

Short workshop formats

In order to reach as many teachers as possible, we designed our training sessions to fit into established and familiar formats and time frames which was also in accordance with the TrainDL project proposal. As a result, the workshops were primarily offered as part of established teacher training events, which determined the format. While experimenting with training formats has been an enriching experience overall, and we recommend continuing to offer training within familiar teacher events as a best practice, we recognize that the limited length of the training (typically 1.5 to 7 hours) is a significant challenge when training teachers on a new topic. While this timeframe is sufficient to try out selected materials, teachers reported the need to continue learning about the topics in order to actually integrate and use the materials provided in the classroom. Even participants in longer training formats, such as 2.5-day workshops, expressed the need to learn more about the topic before being qualified to integrate the new topic and materials into their teaching.

2.5-days workshop format

During the three rounds of interventions, we offered three 2.5-day workshops, two for CS teachers and one for all teachers. In our experience, teachers reported that these workshops were very enriching because they had time to gain deeper insights into the topic of AI and data, learn from industry experts about the state of the art of AI in their respective subjects, and build a community of practice. The longer formats allowed participants to connect with each other and share ideas for teaching the topic with their peers, an experience most teachers do not have due to their busy schedules. Therefore, we found this format to be a best practice. However, we also point out some challenges to consider: finding 2.5 days on the weekend is not possible for all teachers. Therefore, in order to include all teachers, it is still necessary to fit the teacher training into established formats or to offer such workshops in a flexible format (e.g. online course, blended learning course over a longer period of time, such as six months or a year). In some interventions, we found that the school did not support teachers to attend the training. For example, in Lithuania, teachers were not released for the training and the event took place after school hours, on a Friday afternoon, which affected the receptiveness and concentration of the participants.

Building community of practice

We found that of all training sessions, those with the longest duration were the most successful in terms of communication among participants, collaboration, and building a community of practice. The longer formats encourage interpersonal exchanges between teachers. Including common activities, such as visiting the "I AM AI" exhibition or going on a hike, helped teachers connect with open-minded people, build new friendships, which opens new avenues for professional exchange, and build a long-term community of practice.

Working with data

The learning activities that involved working with data, particularly in Orange3 or Jupiter Notebooks, appeared to be challenging for many teachers, with and without a background in computer science. Teachers repeatedly reported that it takes a significant amount of time and effort to become familiar enough with an application to actually use it to teach their students. Some STEAM teachers had tremendous difficulty understanding the processes of data exploration and using it in the AI systems for data-driven decision making. Here, our best practice was to reach out to the didactics of the respective subjects to better understand the current developments within the subjects and to jointly develop approaches to integrate data-driven approaches into teacher training. For example, we found the focus group sessions in which we selected appropriate problems in collaboration with STEAM education practitioners and received feedback on our teaching activities to be very enriching.

Integrating the topic of ethics

AI is having a profound impact on people's daily lives and society as a whole. However, it is challenging to have an informed discussion about ethical issues around AI without understanding how AI systems are built, how they work, what data they are trained on, and how they process the data (see Dagstuhl Triangle Pedagogical Framework [1] and AI-PACK [2]). Therefore, one of our best practices was to focus on the technological concepts that explain how AI systems work before introducing the topic of ethics. Additionally, we used examples from students' everyday lives to discuss the ethical implications of AI systems with

teachers. For example, the workshop design for the first round of interventions included a case study in which participants develop a machine learning system to predict grades based on an anonymized dataset of Portuguese students and their demographics, after discussing what an AI system can and should do. To help teachers understand how mistakes in the selection of training data can lead to misclassifications and what ethical development of AI systems looks like, we developed an additional activity on algorithmic bias for the third round of interventions. With STEAM teachers, we also successfully discussed the responsible use of AI chatbots in schools after they gained experience with the technical aspects of creating and using language models.

[1] Brinda, T., Diethelm, I. (2017). Education in the Digital Networked World. In: Tatnall, A., Webb, M. (eds) Tomorrow's Learning: Involving Everyone. Learning with and about Technologies and Computing. WCCE 2017. IFIP Advances in Information and Communication Technology, vol 515. Springer, Cham. https://doi.org/10.1007/978-3-319-74310-3_66
[2] Lorenz, U., Romeike, R. (2023). What Is AI-PACK? – Outline of AI Competencies for Teaching with DPACK. In: Pellet, JP., Parriaux, G. (eds) Informatics in Schools. Beyond Bits and Bytes: Nurturing Informatics Intelligence in Education. ISSEP 2023. Lecture Notes in Computer Science, vol 14296. Springer, Cham. https://doi.org/10.1007/978-3-031-44900-0_2

AI and data literacy self-assessment and knowledge test

Throughout the evaluation process in the first two rounds of interventions, we observed that not all teachers who participated in the training took the AI and data literacy self-assessment and knowledge test, which is unfortunate since pre-activating participants' knowledge should enhance the training experience and make teachers curious about the subject and new topics. Participation in the post-test was even lower, which is unfortunate since the original idea of the test was primarily to show teachers their progress in AI and data literacy. Participation in the questionnaires sent out 6 months after the training was also very low.

Possible explanations for teachers' non-participation could be that (1) there were too many questionnaires to fill out (2 before the training, 2 after the training, 1 after 6 months), (2) teachers left the training venue early and did not have time to fill them out at home, (3) since the post-test is the same and not graded, teachers were not motivated enough to spend another 10 minutes on the last knowledge assessment. The response rate improved after we combined all surveys into one pre- and one post-questionnaire in the third round of the intervention. However, we still faced the challenge of reaching teachers who had attended the training six months after the intervention to understand whether they had actually integrated the topic of AI and data literacy into their teaching.

Unplugged and plugged teaching approaches

In introducing AI and data literacy, we used both unplugged approaches - activities that help students understand computer science concepts without turning on the computer - and plugged approaches, such as analyzing data in the Orange3 data mining tool or in Jupiter Notebooks. Both approaches received positive feedback from teachers. However, we also observed some challenges.

We received feedback that the unplugged activities were a great exercise to introduce students to the concepts of AI and data science. However, we noticed that when it comes to transferring the theoretical concept, e.g. the principle of classification from the "Good monkey, bad monkey" game to the use of decision trees

in tools like Orange3, teachers have many questions (e.g. how exactly was the decision tree created? Where and how was the model trained? How can I use the model further?) When it came to real-world data processing - moving from analyzing small data sets to analyzing real-world data sets and automatically building the AI models - teachers felt increasingly uncertain. This observation is consistent with the feedback from one teacher in the interview who noted that the transition from basic concepts to application of knowledge is very steep: "The other tool was this Orange3. It's maybe a little bit more accessible than Python because it's just visual, it connects these nodes, but the learning curve is still, I think, relatively steep. For me personally and probably for my students as well" (weekend workshop, interview #2).

Transferring abstract ideas to real-world examples

We experienced a bumpy transition from the theoretical introduction of the concept of AI and the data lifecycle to the application of theoretical concepts to real-world problems. Previous research suggests that the best learning experiences for most people occur when they are actively involved in designing and creating things, especially things that are meaningful to them or others around them (Resnick & Silverman 2005). Thus, we experimented with the real-world case studies in which teachers collected the data during the 2.5-day workshops and worked through the data lifecycle with their data. Our experience with this process was that it was time-consuming and, according to the teachers, not an appropriate approach to use in school. However, we still experienced that this approach has a learning potential, and future projects could work with data science experts from the field working with real-world problems, domain experts, and teachers to design teaching approaches for AI and data that are specifically tailored to the real-world problems in the school context.