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ComputingEducation

Computer science explained!

Introduction of AI Literacy and Data Literacy in Computer Science Teacher Education

The key to successful integration of AI&DL into school education is effective teacher preparation.

In order to thrive in a data-driven world, school students need to become familiar with artificial intelligence (AI) from an early age [1] and develop AI literacy and data literacy (AI&DL). The former is a set of competencies that enables individuals to understand and critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace [2]. The latter is the ability to collect, manage, evaluate, and apply data, in a critical manner [3]. However, the key to successful integration of AI&DL into school education is effective teacher preparation. Despite the growing body of research on AI education, there is a lack of knowledge about AI teacher training programs for K-12 education, according to a recent literature review [4].

Through our research, we are taking a step toward research-based teacher education in AI&DL. Informed by the requirements for professional teacher development programs that we gathered in a dialogue with European stakeholders and by reviewing European educational policies, we developed a **one-day professional development program** for in-service computer science (CS) teachers with no to some prior knowledge in AI&DL and evaluated it with CS teachers from Germany, Austria, and Lithuania.

BACKGROUND

In a recent systematic literature review, Sanusi et al. [4] found that there is dearth of the teacher training programs that comprise AI for K-12. However, there are a number of educational guidelines and recommendations recognizing the need for professional development of in-service teachers.

For example, a recent OECD education working paper stated that continuing professional learning is vital for teachers to broaden and deepen their knowledge, keep up with new research, tools and practices and respond to their students’ changing needs [5].

Regarding education on technological developments, the European Union (EU) recently published the European Digital Competence Framework DigComp 2.2 [6]. The document includes a list of more than 80 examples of knowledge, skills and attitudes related to citizens interacting with AI systems. Data literacy is one of five competence areas of the framework. For teachers specifically, the EU has published the Framework for the Digital Competence of Educators (DigCompEdu), which focuses specifically on digital competences for teachers [7]. The most recent version of this document is from 2017, and does not mention data literacy or AI literacy.

RQ 1 & 2

(1) What is the effect of the designed program on teachers‘ perceived competence to incorporate AI&DL into their teaching and on their understanding of AI&DL concepts?

(2) To what extent are teachers able and willing to incorporate AI&DL content introduced in the program into their teaching, and what are the potential barriers?

OUTLINE OF THE TEACHER TRAINING

AI Bingo | Recognize AI in real-world settings and activate prior knowledge

Round of introductions | Participants and the facilitator know each other

Intro to AI and AI&DL | Become familiar with AI terminology; be aware of international guidelines on AI&DL and national curricula including AI&DL

Beat the robot | Explain the idea of rule-based AI and contrast it and reinforcement learning approach.

Customer prototypes | Experience and explain the unsupervised learning paradigm

Biting and non-biting monkeys | Experience and explain the supervised learning paradigm

First steps in Orange3 | Explore Orange3 and implement an explorative data analysis workflow

Data analysis project | Create, train and test predictive models with the data mining tool Orange3

Intro data literacy and data lifecycle | Know the data analysis workflow; understand basic statistical concepts

Review and discussion | Visualize ways to integrate activities in their own classroom

TRAINING CONCEPT

We developed a one-day (7-hour) teacher training concept that includes two components: (1) content knowledge (based on the **Dagstuhl triangle** framework [9]) 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 [2, 10].

For the pedagogical knowledge, we based the training on the **didactic biplane** which is commonly used for CS teacher training [11]. We used research-based open-source unplugged learning materials for machine learning and rule-based AI published under a free license by Wissensfabrik [12]. For the data lifecycle, we chose the computer-based activity in Orange3 [13], also published by the Wissensfabrik [12].

METHOD

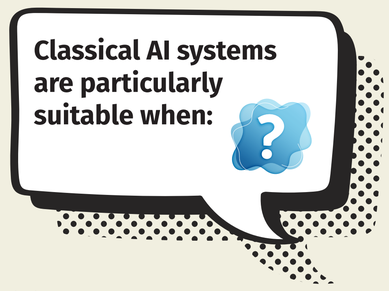
In order develop a professional development program, we followed the **action research** approach [8].

Phase 1 – Understanding Practice: We conducted research on the availability and common practices of teacher training for CS teachers.

Phase 2 - Deliberate Improvements: We designed a one-day teacher professional development program on AI&DL for teachers.

Phase 3 - Implement and Observe Improvements: We implemented the developed program in Germany, Austria, and Lithuania.

We collected quantitative data through pre- and post-evaluation surveys, as well as pre- and post-knowledge tests to evaluate the effectiveness of the intervention. We also collected qualitative data via semi-structured personal interviews. The interviews provided insights into the participants’ perspectives on the training and their thoughts on integrating AI&DL into their teaching practice.



(A) the number of possible results grows exponentially with increasing input parameters;

(B) expert knowledge is available;

(C) the problem space can be described unambiguously;

(D) the application requires speech or image recognition;

(E) I don’t know.

RESULTS

We evaluated the impact of the training concept in three sessions with **70 CS teachers** from Germany, Austria and Lithuania. The results of the evaluation showed that the training in all three countries had some **positive impact** on teachers’ perceived competences on how to use **AI content** in class, as well as teachers’ understanding of AI concepts introduced in the training. Results were **mixed for DL content**: improvements in this area showed high variability with no apparent increase after training.

Participants in all three countries reported that the training served as a valuable introduction to AI and DL. However, the depth and complexity of certain topics, especially in the realm of AI, were challenging for participants. **Exercises using the Orange3 tool consistently received mixed feedback**. While some teachers found it suitable for teaching, others found it too complex and criticized its graphical interface and lack of programming features as a deterrent for more advanced students.

In terms of teachers’ perceived **ability and willingness** to integrate the AI&DL into their teaching, participants highlighted several difficulties. While teachers felt more prepared to integrate the AI&DL content presented in the training into their classrooms after attending the training, integration would require further engagement with the material.

A single 7-hour course was not sufficient to ensure the integration of DL and AI into the classroom, especially if teachers had not taught these subjects prior to the training. Teachers expressed a **strong desire for further training**, concrete course plans and materials tailored to specific grade levels to streamline integration into teaching and reduce their preparation workload, which corresponds with prior research on professional training programs for CS teachers [13].

The **main barriers** for CS teachers to implement AI&DL in their classrooms were lack of knowledge and time constraints such as current workload.

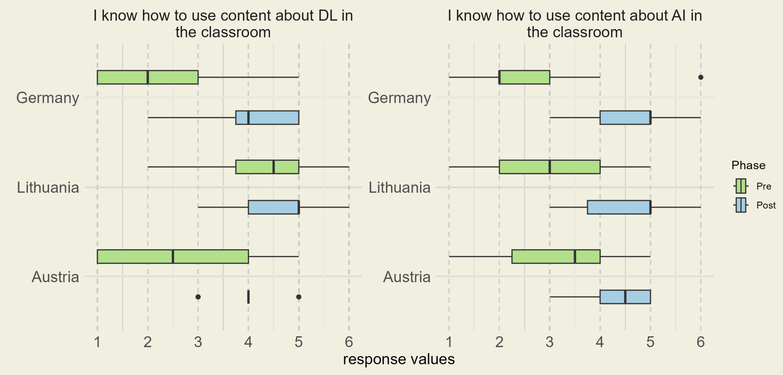


Fig. 1. Response distributions for the pre- and post- results of the survey on teachers’ perceived competences to introduce AI&DL-related content in the classroom. For each item, teachers were asked, “How much do you agree with the following statements?” and were given a scale from 1 (not at all) to 6 (definitely).

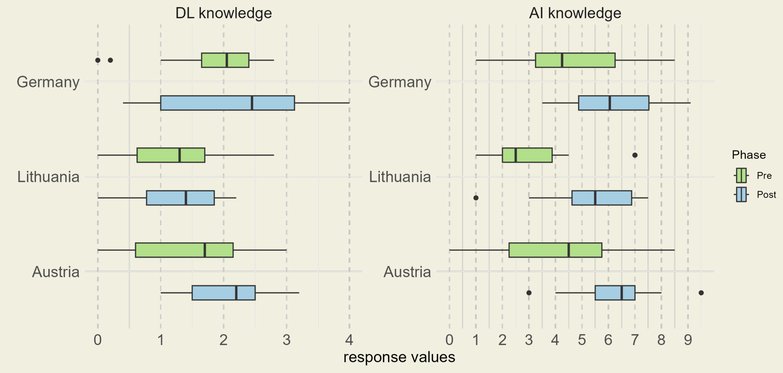


Fig. 2. Response distributions for the pre- and post-results of the knowledge test. The test consisted of four knowledge questions for the DL dimension and ten for the AI dimension. For example, in Germany, the average number of correct answers for the AI dimension was 4.1 before training and 6 after training.

more about our research

ACKNOWLEDGMENTS

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TrainDL