Extended Abstract for the
Symposium on Integrating AI and Data Science into School Education Across Disciplines 2025

EDUCATION WITH AND ABOUT AI: IMPLEMENTATION OF A PARTICIPATORY TEACHING PLATFORM

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Focus Topics: Learning Materials, AI and Data Science Competencies

Introduction[1]

Due to the significance that AI applications already have for our society, AI education is considered an important part of contemporary education. Moreover, the topic of AI provides an interesting field of activity and subject area for various school subjects – especially for computer science and mathematics education. The importance of AI education is now reflected in various computer science curricula in Germany and Austria. A key challenge for the comprehensive implementation of AI education and the holistic promotion of AI literacy in school is, on one hand, the availability of high-quality and up-to-date teaching and learning materials adapted to target groups and curricula, as well as the training of teachers in the field of AI. We address these challenges by providing teachers with materials for lessons on AI and machine learning through the teaching platform kiwi.schule and by training and educating (preservice) teachers through professional development courses and university seminars. Through the teaching and learning materials described below, exemplary lesson plans, a classroom management system, and AI tools for lesson preparation, teachers are supported in designing, adapting and teaching lessons on AI. The provided content aims to address and promote AI literacy and related competencies at different levels of cognitive learning objectives.

The term "AI Literacy" is not uniformly defined in the literature (Kandlhofer et al., 2016; Laupichler et al., 2022; Long & Magerko, 2020; Ng et al., 2021). As an example, Long and Magerko (2020) provide the following definition: "We define AI literacy as a set of competencies that enables individuals to critically evaluate AI technologies; communicate and collaborate effectively with AI; and use AI as a tool online, at home, and in the workplace". Many of the definitions implicitly or explicitly reference the various categories of the revised Bloom's Taxonomy of cognitive learning objectives (Bloom, 1956; Krathwohl, 2002). This is explicitly elaborated by Ng et al. (2021). The authors identify four aspects for promoting AI Literacy: "Know and Understand AI", "Use and Apply AI", "Evaluate and Create AI", and "AI ethics", and further break these down with reference to the revised Taxonomy (Tab. 1). Ng et al. (2021) thus expand the competencies subsumed under AI Literacy to include the development of AI applications and incorporate complex cognitive activities.

An open challenge is to translate the abstract principles of AI Literacy into concrete learning formats that are also practically applicable in school education. In the following, we present how AI Literacy is operationalized on our teaching platform kiwi.schule by suitable teaching-learning formats for each category of the learning objective taxonomy. This is intended to address or initiate more complex cognitive learning objectives and thought processes (evaluate, create, Tab. 1). The learning formats are not static but can be edited, flexibly compiled, and supplemented by teachers and instructors at universities or teacher training centers.

Teaching-learning concept for the holistic promotion of AI literacy

The platform provides a wide range of teaching materials on AI and machine learning for computer science. These materials are aligned with the computer science curricula of various regions in Germany (e.g. in Bavaria and Hamburg). In addition, several learning units are provided focusing on mathematics education.

The rapid advancements in AI research are in contrast to the relatively static nature of curricula. Therefore, the platform goes beyond the curricula by offering AI-focused excursions on current technological developments, their applications, and associated societal implications. The materials are developed by an interdisciplinary community of AI experts from research and industry, educators, and

[1] This abstract is a modified version of the German publication by Schönbrodt et al. (2024).

In S. Podworny & S. Schönbrodt (Eds.), *Towards Fostering AI and Data Science Literacy in Schools Across Disciplines. Proceedings of the 1st Symposium on Integrating AI and Data Science into School Education Across Disciplines (AIDEA1 2025)*, Salzburg, Austria.

educational scientists to ensure scientifically and pedagogically sound materials. The teaching and learning materials comprehensively address the categories of cognitive learning objectives in the revised Bloom's Taxonomy. In assigning materials for specific categories, we follow the framework provided by Ng et al. (2021) (cf. Tab. 1). Using the topic of "fairness in machine learning" as an example, below we briefly discuss a learning activity and developed material spanning the taxonomy levels "apply", "analyze" and "evaluate".

Blooms Taxonomy	**Taxonomy for AI Literacy**	**Realization on kiwi.schule**
Remember	Know facts, principles, and fundamental concepts: Know the basics of AI and machine learning	*Formats*: Slide sets; animations; explorables (Teachable Machine, Tensorflow Playground, AI Chat Playground); explanatory videos; interactive worksheets *Exemplary contents:* Structure of a perceptron, neural networks, activation functions, N-gram models, categories of machine learning (supervised, unsupervised, reinforcement learning)
Understand	Explain ideas and concepts: Describe, elucidate, interpret & demonstrate the fundamentals of AI	
Apply	Apply information in new situations: Use and apply AI tools in various contexts; apply learnt machine learning concepts in familiar context	*Formats:* AI tools for experimentation (AI chatbot; image generator); exercises in prompt engineering; Jupyter Notebooks *Exemplary contents:* Guidelines for the use of AI tools; worksheets on possibilities and limitations of generative AI; programming exercises in Jupyter Notebooks to implement simple supervised learning algorithms (e.g., a small neural network)
Analyse	Break down information and establish relationships: Compare, analyze, and abstract AI applications	*Formats:* Slide sets; case studies; value-based evaluation schemes; explorables (Teachable Machine, AI chatbot, image generator) *Exemplary contents:* Value-based analysis of AI systems in diverse case studies (regarding transparency, privacy, fairness, etc.); regulations (e.g., AI Act)
Evaluate	Evaluate a position: Ethically and technically examine AI applications and evaluate outputs of AI tools	
Create	Produce new or independent works: Design, compile, construct, develop & implement AI systems	*Formats:* Jupyter Notebooks via Jupyter Hub *Exemplary contents:* Project proposals and datasets for implementing own AI projects; worked examples of AI projects

Table 1: Version of Bloom's taxonomy revised by Krathwohl (2002) with reference to AI literacy (based on and adapted from Ng et al., 2021, Fig. 2) and implementation on kiwi.schule

Case Study: Fairness of Machine Learning systems

A topic of particular interest across the taxonomy is Machine Learning fairness. Wattenberg, Viégas and Hardt (n.d.) discussed this topic in a blog post, designing interactive elements for communicating the main findings of Hardt, Price & Srebro (2016). The paper discusses the fairness of different scoring systems, and shows that it is impossible to satisfy a set of reasonable measures of fairness at the same time. Because of the technical impossibility of satisfying all measures, the choice of measures to satisfy becomes a value-based decision. Only after this decision has been reached, the technical implementation follows.

Based on the original blog post, we developed a web application to make this topic amenable to the school context. Our app enables students to elaborate and analyze different definitions of fairness in the development of data-based algorithms in the context of credit granting. Students discuss how decision boundaries for two groups of people can be chosen to make the credit granting system as fair as possible. It becomes evident that various approaches and definitions of fairness exist, each with different advantages and disadvantages, and a precise mathematical definition (e.g., matching the positive rate or true-positive rates of a classifier). The activity allows for deepening knowledge in the

area of frequency diagrams, particularly scatter plots, as well as statistical metrics and highlights the role of data for the development of machine learning systems (Schönbrodt et al., under review).

Participatory design of AI education

To facilitate the contribution of new content, the platform's architecture is modeled after existing systems with contribution workflows. The platform is built on the open-source software Gitea, through which contributions can be submitted and existing applications can be revised. The content is hardly restricted technologically, with possible content types currently including (1) containerized web applications, (2) interactive whiteboards and worksheets (e.g., H5P, HTML/CSS widgets), and (3) classic static materials (slide decks, worksheets). This model follows the approach of Hugging Face: In addition to code and documentation, complete applications including front and back end are provided and can be used without installation effort.

Target groups for the platform include not only teachers and students but also researchers from AI and educational research. For AI researchers, the platform offers a resource for science communication. Current research results can be shared throughout the German-speaking world. For educational researchers, the platform offers the opportunity to distribute teaching-learning material from design-based research projects and to test it with a large number of students. Empirical research projects, e.g., to assess AI competencies, are supported through exclusive surveys in the context of previously approved studies or based on pseudonymized data.

Conclusion

The rapid developments in AI and other digital technologies pose a significant challenge in designing future computer science and mathematics curricula. Learning objectives and corresponding materials must be continuously updated with new scientific findings and technical methods. Here, we presented an open platform that can quickly respond to these changes and may serve as a digital textbook. For the topic of AI, the platform demonstrates how material can be holistically developed along the revised Bloom's Taxonomy and made available for classroom use. The focus on web-based materials enables flexible use – assuming a digital school infrastructure is in place. To facilitate the flexible integration of the platform into schools, it is GDPR-compliant and APIs to common teaching-learning management tools in schools (e.g., Moodle) can be easily created.

Further contributors and acknowledgement

Contributors of the KI macht Schule team: J. Albers, J. Beck, T. Camminady, H. Dohmen, L. M. Helleckes, A. Jankowsky, L. S. Krapp, M. Müller, E. Nguyen, S. Onasch, K. Rau, N. Rehbach, J. Reher, P. Pommer, T. Schmidt, F. Schropp, A. Schulz, M. Stock, M. Süßmilch. The project was funded by the Dieter Schwarz Stiftung Heilbronn, aqtivator gGmbH and the Civic Innovation Platform (BMAS). We thank the Tübingen AI Center for their support and all volunteers of KI macht Schule for their commitment.

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