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

SHAPING THE FUTURE OF EDUCATION: AI AND DATA SCIENCE LITERACY AS A CIVIC IMPERATIVE IN EDUCATION

Sarah Schönbrodt[1] & Susanne Podworny[2]
[1]Paris Lodron University of Salzburg, Austria, sarah.schoenbrodt@plus.ac.at
[2]Paderborn University, Germany

Focus Topics: Data and problems, Tools, Explanatory Models, Learning Materials, AI and Data Science Competencies, AI and Data Science Curricula and Implementation in School, AI and Data Science Education for Social Good

Introduction

The accelerating integration of artificial intelligence (AI) and data science into societal infrastructures is transforming how individuals interact, work, and make decisions. These changes are particularly pronounced for young people, whose lives are increasingly shaped by digital technologies. As AI systems become ever more pervasive, education systems must respond by equipping students with the knowledge, skills, and critical perspectives necessary to thrive in a data-driven world (Long & Magerko, 2020; Schüller, 2022; UNESCO, 2024). The Symposium on Integrating AI and Data Science into School Education Across Disciplines (AIDEA), convened in Salzburg, Austria, from February 24–28, 2025, addressed these imperatives by providing a platform for interdisciplinary exchange among over 60 international researchers, educators, and policymakers.

This introductory paper highlights the symposium's central themes and synthesizes the key insights and major findings presented in the symposium.

Rationale and Vision

AI technologies now affect nearly every aspect of daily life and are predicted to exert even greater influence in the future. For today's students, understanding AI is not merely an advantage but a necessity for active participation in society (UNESCO, 2024). The symposium was founded on the premise that AI education must be discussed from diverse educational perspectives and implemented at an early stage. This includes fostering a robust understanding of how AI systems operate and the crucial role of data in shaping their behavior, as well as their limitations, risks, opportunities, and creative potentials.

In parallel, the dramatic growth of data in the digital age has made data science literacy indispensable (Schreiter et al., 2024). The ability to analyze and interpret data is crucial for making informed decisions in a wide range of fields. Data science literacy empowers students to extract valuable insights from vast datasets, enabling evidence-based decision-making and the capacity to solve complex problems (Biehler & Schulte, 2018; Schüller et al., 2021).

Thus, the symposium's vision extends beyond the mere use of AI technologies in educational contexts. Its focus is on education for learning AI and data science, specifically the development of mathematical, statistical, and computer science competencies that underpin AI and data literacy. The goal is to prepare students not only to use technology, but to understand, critique, and innovate with it.

AIDEA was designed to serve as a dynamic platform for presenting and discussing ongoing research projects, findings, ideas, and initiatives in the field of AI and data science education.

Overview of the contributions

This volume brings together 34 contributions that explore how artificial intelligence (AI) and data science can be meaningfully integrated into education across levels, disciplines, and educational contexts. The chapters are organized into seven thematic strands: (1) Data literacy and statistical thinking, (2) Learning resources for AI education, (3) Curriculum development and educational policy, (4) Ethics, society, and critical reflection, (5) Pedagogical strategies and teacher education, and (6) Mathematical and technical foundations of AI. Each strand reveals how AI and data science education can be designed, implemented, and reflected upon to foster empowered and critically literate learners.

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.

Data Literacy and Statistical Thinking

In his contribution, **Bathke** emphasizes that data, not algorithms, are central to data science and AI. He emphasizes that high-quality data is more important than relying on big data or complex algorithms—and this should be a key focus in education. **Erickson** makes it clear in his contribution that, despite its complexity, data science can be taught in schools in a simplified, age-appropriate form. The contributions of Erickson as well as Hüsing and Podworny promote student-centered data exploration via "data moves," empowering learners to transform and question data meaningfully. **Hüsing and Podworny** emphasize that data explorations are central to fostering statistical thinking in scaffolded environments like CODAP or Jupyter Notebooks, enabling students to develop epistemic agency through data-driven knowledge construction. **Binder and Rößner** report in their contribution on a workshop for gifted secondary students who learnt significance tests and p-values using simulations and software, focusing on conceptual understanding and common misconceptions. The authors suggest that explicitly discussing such misconceptions is necessary. **Eckert, Schönbrodt, and Frank** highlight the importance of data cleaning in data science education, noting its significant impact on model outcomes. Their design research project develops materials focused on mathematical foundations, where students use real datasets and interactive Python notebooks to explore how outliers affect predictive models. **Weiland's** contribution adds a literacy-oriented approach to teacher education, focusing on visualizations as a core concept for developing critical statistical literacy. His framework emphasizes "reading the word and the world" through critical statistical practices centered on data visualization literacy.

Learning resources for AI education

In their contribution, **Höper and Fleischer** explore dual learner roles—user and designer—through explanatory models for AI systems. They present two teaching approaches aimed at helping students understand data-driven technologies and become critical, informed citizens. **Mühling and Scheppach** emphasize an understanding perspective to AI algorithms. They develop a diagnostic assessment involving concept cartoons to determine students' stages of understanding of the AI learning process. **Waite and Sentance** introduce "Experience AI," a free, modular curriculum co-developed with DeepMind for introducing AI and machine learning to 11–14 year olds. The materials build on design principles such as clear objectives, avoiding anthropomorphization, real-world examples, core vocabulary, computational thinking 2.0, and strong teacher support. In his contribution, **Heusel** presents inf-schule.de, an open online textbook widely used in German computer science education, which offers interactive, real-world AI learning paths for students aged 10–14. The materials emphasize problem-solving, interactivity, and gradual, self-directed learning, covering topics like supervised learning, decision trees, and reinforcement learning. **Schönbrodt, Schneider, and Berberich** present the *kiwi.schule* platform, which provides adaptable, curriculum-aligned teaching materials and professional development for teachers. Their approach operationalizes AI literacy across all levels of Bloom's taxonomy using interactive tools, real-world case studies, and project-based learning. A key example is a web app on fairness in machine learning, enabling students to explore technical and ethical aspects of AI decisions. **Tedre and Vartiainen** present four AI-driven tools to support data agency for young students. In their contribution, they outline the pedagogical ideas of the development of the tools GenAI Teachable Machine and GenAI Somekone to foreground explainability and algorithmic bias in social contexts. **Farrell** outlines the Data Education in Schools project in Scotland, which builds data and AI literacy for ages 3–18 through creative, interdisciplinary, and gamified activities. Teachers are supported with resources and professional communities, while students engage in hands-on problem-solving, escape room games, and live lessons—often without needing technology. Recent efforts include expanding these playful approaches to AI education and developing new resources on ethical AI use with teachers across Scotland.

Curriculum Development and Educational Policy

The contribution of **Biehler and Schulte** presents the ProDaBi project that blends statistics, computer science, and societal reflection into an interdisciplinary curriculum. Five core aspects and initiatives are presented that provide a specific approach to integrating data science and AI into education. **Engel's** contribution frames data science as a tool for civic engagement to equip all learners with critical, ethical, and contextual understanding of data and algorithms. Engel stresses that

educational policy should support interdisciplinary, problem-focused approaches to prepare citizens for informed participation in a data-driven society. **Geroldinger** critically reflects on Austria's efforts to systemically embed AI and data education in the new school subject "digital literacy." He discusses three key elements as necessary requirements: qualified teachers, appropriate teaching resources, and a framework. In her contribution, **Olari** highlights the important role of data when teaching AI topics. From this perspective, she contributes a comprehensive model of 28 data-related practices and a collection of 155 data-related concepts for AI curricula. While Olari focuses on the foundational role of data in AI education, **Miller and Wilkerson** expand the scope by addressing how students' understanding of data science can systematically develop over time. Their contribution describes a proposed U.S. framework of learning progressions for K–12 data science education—a very large and complex undertaking. They suggest that this can serve as a guide to policy makers, practitioners and researchers. **Huber, Schüller, and Drauz** contribute a framework for data and AI literacy to be aligned as an European IEEE standard. This framework targets diverse groups by introducing hierarchical competency levels and additionally emphasizes ethical awareness and critical reflection of data and AI. **Smith and Kathotia** discuss how integrating data science into UK mathematics school curricula requires a rethinking of competencies—emphasizing iterative, contextual, and ethical inquiry at the intersection of mathematics, statistics, computing, and data science. Such integration can fundamentally shift how mathematics is taught, moving toward a more holistic, critical, and interdisciplinary practice. **Pears** argues that generative AI exposes fundamental flaws in traditional education, especially assessments focused on final products. As AI can now produce high-quality work instantly, education must shift toward teaching and assessing learning processes and AI-related competencies. Universities, he contends, must urgently revise curricula to integrate field-specific AI skills and prepare students for an AI-driven workforce. **Gal's** contribution calls for a rethinking of statistics and computer science education from two perspectives. First, current educational approaches to data science often emphasize a "producer" perspective, rather than equipping all students to engage with data-driven technologies as informed "consumers." Second, these approaches tend to serve only a small portion of students—typically those who are high achievers in mathematics or computing. For these reasons, Gal highlights the need for systemic and instructional changes to support data science literacy for all learners.

Ethics, Society, and Critical Reflection

In their contribution, **Verständig, Kuhnla, and Ahlborn** emphasize the importance of inclusive and ethical data literacy in education, highlighting the need to address inequalities and promote social good. They propose integrating creative and feminist approaches into curricula and introduce a game-based open educational resource to make data concepts accessible and engaging. **Gapski** proposes in his contribution the metaphor of society as an "algorithmic social machine" to help students critically understand the pervasive impact of datafication and algorithmic regulation. He argues that education should go beyond digital skills to foster critical awareness of the ethical and societal dimensions of digital technologies. **Berges and Vollhardt** highlight how the rise of AI and digitalization is transforming both society and computer science education, creating new interdependencies between technology and the environment. They argue in their contribution that computer science education must go beyond technical skills to address the societal, ecological, and ethical impacts of AI, and call for integrating these perspectives into curricula and teacher training. **Andersson** presents unplugged, discussion-based learning materials for upper secondary mathematics that introduce data science concepts alongside ethical and sociopolitical issues. Through activities like building decision trees with cartoon data and analyzing real Facebook data, students explore how models are constructed and how data can reflect or reinforce societal biases.

Pedagogical Strategies and Teacher Education

Gaertig-Daugs and Schmid emphasize the importance of teaching data and AI literacy in primary schools, as digital technologies are already part of young children's lives. They developed a massive open online course to equip primary school teachers with foundational and didactic skills in data science and AI, structured into five practical modules. **Kölling** shares in her contribution how Hamburg's AI Competence Center supports teachers in integrating AI into schools through targeted training and collaborative initiatives. By combining technical, practical, and critical reflection—such as projects on AI and disinformation—teachers and students are supported in developing AI literacy and

learn to use and assess AI responsibly. **Hazzan** argues that generative AI (GenAI) offers new opportunities for computer science and data science education by allowing students to tackle more complex, creative, and abstract tasks without being hindered by technical details. GenAI can support personalized, learner-centered pedagogy and help develop critical skills like computational thinking, metacognition, and ethical technology use. **Waite** points out that teaching students "AI interaction competencies" are essential for AI literacy. The author also introduces Legitimation Code Theory (LCT) as a tool for analyzing and improving the quality of AI explanations, suggesting that teaching students to evaluate and prompt for better AI explanations can enhance learning and equity.

Mathematical and Technical Foundations of AI

Frank examines in his contribution how key mathematical concepts underlying supervised deep learning can be demystified in high school education. He highlights that by reframing AI terminology into classical math (e.g., neural networks as piecewise affine-linear functions) and leveraging existing curriculum elements like calculus and linear algebra, students can grasp how neural networks approximate complex functions and are trained. Building on this**, Kindler, Schönbrodt, and Frank** present an intended learning path for integrating artificial neural networks (ANNs) into high school mathematics, using function analysis and interactive digital tools to help students understand how ANNs work. By analyzing and modifying simple networks, students connect mathematical concepts to AI, explore how parameters affect outcomes, and discuss limits like generalization. In a related direction, **Bata and Frank** propose integrating unsupervised machine learning methods like k-Means and DBSCAN into German secondary math education, emphasizing their mathematical foundations in distance metrics and density concepts taught in schools. **Bilstrup** highlights how the rapid adoption of large language models (LLMs) like ChatGPT is transforming classrooms, work, and society, requiring students to develop deeper understanding and critical skills beyond basic usage. He argues that education must address not only how to use LLMs, but also their underlying mechanics, social biases, environmental impacts, and the global labor involved in their development.

Conclusion and Outlook

Collectively, these 34 contributions present a multidimensional vision for AI and data science education—one that is age-appropriate, inclusive, interdisciplinary, and socially conscious. They advocate for educational systems that empower all learners not only to use AI technologies, but also to question, interpret, and shape them. As this volume demonstrates, AI literacy is not merely a technical skill but a civic and ethical imperative, requiring thoughtful pedagogy, forward-thinking policy, and a shared commitment to equity and critical understanding (Engel, 2017).

The integration of AI and data science into school education is a complex and urgent challenge (Biehler et al., 2018). AIDEA 2025 served as a unique platform for advancing research, sharing innovations, and identifying critical issues. These proceedings reflect the diversity of perspectives and the collective commitment to shaping the future of AI and data science education. The establishment of AIDEA as a recurring symposium, together with the development of open-access resources and collaborative networks, marks a significant step toward achieving equitable and impactful AI data science education on a global scale.

The symposium raised a range of open questions that invite further research and dialogue: How can educators effectively balance teaching with and teaching about AI to promote both practical skills and critical understanding? What conceptual frameworks are best suited to support foundational AI education, and how can these be made accessible across different educational levels? Given that many teachers currently lack formal training, what forms of professional development are most effective in building their confidence and competence in AI and data science education?

A recurring challenge is the disconnect between curricular frameworks and classroom realities. How can this gap be bridged through empirically validated teaching models, adaptable resources, and meaningful assessment tools? What role should interdisciplinary collaboration play in designing such models, and how can partnerships between computer science, statistics, ethics, and subject didactics be fostered in practice?

Moreover, how can educators ensure that the tools and metaphors used to teach AI are both age-appropriate and conceptually accurate? What strategies are needed to support learners in engaging with

AI not only as a technical phenomenon but also as a social, ethical, and environmental issue? And finally, how can we design teacher training programs that not only transfer knowledge but also empower educators to navigate and shape the evolving landscape of AI in education?

These questions mark important directions for future research, policy, and practice—calling for collaborative, interdisciplinary efforts that position AI literacy as a critical component of democratic education.

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