Addressing AI and Data Literacy in Teacher Education: A Review of Existing Educational Frameworks

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ABSTRACT

Being able to use data and AI technologies responsibly is considered increasingly relevant to all school subjects. Despite this trend, existing AI literacy frameworks used to design educational activities often barely cover data literacy. However, AI cannot be appropriately grasped without data literacy, and working with data requires knowledge of AI on multiple levels. To date, though, no framework has been created that considers AI and data literacy holistically. To address this gap, we examine the relationship between AI and data literacy competencies in existing educational frameworks and propose a preliminary approach that utilizes the data lifecycle to reflect on data literacy competencies relevant to AI. The findings provide a basis for developing a comprehensive approach to the education of K-12 teachers of all subjects in AI and data literacy.

CCS CONCEPTS

• **Social and professional topics** → *K-12 education*; • **Computing methodologies** → *Artificial intelligence.*

KEYWORDS

AI Literacy, Data Literacy, K-12 Education, Teacher Education

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1 INTRODUCTION

Artificial intelligence (AI) technologies are widely used in personal and professional contexts. However, many people encounter AI without being aware of it or understanding how the technology functions [13]. This trend has led to political commitments to promote AI and data literacy in school education [4], reflected in the increasing development of K-12 educational frameworks focused on AI and data literacy [1, 2, 9, 15, 16]. These frameworks aim to enable students in all school subjects to critically evaluate AI technologies, use AI as a tool, and consciously deal with data. Nevertheless, multiple educational frameworks often barely cover data literacy or consider data literacy and AI literacy separately. However, data literacy is closely related to the AI subfield of machine learning [9] and AI (especially from a machine learning perspective) cannot be adequately grasped without data literacy. Approaches that address AI and data literacy holistically are still lacking, as are curricula for training K-12 teachers of all subjects [8, 14] that comprehensively link AI and data literacy. This paper focuses on this disparity. We show how data literacy competencies are covered in AI literacy frameworks, identify gaps, and suggest an exemplary approach that utilizes the data lifecycle as a framework for anchoring AI-specific competencies. Finally, we discuss the suggested approach as a step towards comprehensive AI and data literacy education for teachers.

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2 RELATED WORK

Previous research has shown that specific data literacy competencies overlap with AI literacy competencies. [9] propose an approach that classifies learning from data and critically interpreting data as AI-related competencies. Similarly, [11] consider competencies such as creating and evaluating a labeled dataset for training, investigating imbalances in training data as components subordinated to AI. [1, 3, 12, 14] propose approaches to promote AI literacy that include instruction on several data-related skills, such as curating datasets, training a model with data, and recognizing data misuse.

Despite the increasing availability of materials for teacher education in AI, few research-based educational programs have been piloted with K-12 teachers of different subjects. An analysis of the curricula used in these pilot programs shows that they foster data literacy-related skills. For instance, [14] included activities to curate datasets, and use them for training of image classifiers. [12] provide a teacher education curriculum on AI, which helps teachers strengthen data-related competencies (e.g. collecting datasets, maintaining training data diversity for robust image classification).

From a data literacy perspective, existing frameworks view data literacy as a standalone discipline and do not include explicit references to AI content or competencies [2, 6, 10]. Educating teachers of different backgrounds in data literacy is common; however, even then, AI-related competencies are not explicitly fostered [7]. [5] is an exception. They developed a data science curriculum for teachers that they assert enables teachers to explain the relationship between AI, machine learning, big data, and data science.

3 INVESTIGATING AI LITERACY FROM THE PERSPECTIVE OF DATA LITERACY

In order to consider AI and data literacy holistically and identify genuine gaps, we conducted a review of the available AI literacy

	Acquisition	Cleansing	Modeling	Implementation	Optimisation	Analysis	Visualisation	Evaluation	Sharing	Erasing	Archiving
[11]	-	-	✓	-	-	-	-	✓	-	-	-
[9]	✓	-	✓	-	-	✓	-	✓	-	-	✓
[1]	✓	-	-	-	-	-	-	✓	-	-	-
[14]	✓	-	-	-	-	-	-	✓	-	-	-
[3]	✓	-	-	-	-	✓	-	✓	-	-	-
[12]	✓	-	-	-	-	-	-	✓	-	-	-
[8]	-	-	-	-	-	-	-	-	-	-	-

Table 1: Coverage of the data literacy-related competencies in currently available AI educational frameworks, categorized by the stages of the data lifecycle proposed by [6].

frameworks from a data literacy perspective. Since there are few AI frameworks that were explicitly developed for teacher education [8, 12, 14], we also analyzed frameworks used in schools [1, 3, 9, 11]. For analysis, we built our work on the data lifecycle, since it is widely used to categorize and describe competencies that are relevant in data literacy [5, 6, 10]. For each stage of the data lifecycle (*Acquisition, Cleansing, Modeling, Implementation, Optimization, Analysis, Visualization, Evaluation, Sharing, Erasing, Archiving*), we answered the following question: "Is this stage covered by the respective AI literacy framework proposal, and if so, how it is specifically embedded?". Table 1 illustrates the results of the review.

Overall, we found that existing AI literacy frameworks do not comprehensively cover data literacy concepts. Most of the AI literacy frameworks we analyzed include competencies relevant to the *Acquisition* stage of the data lifecycle (e.g., students should collect a dataset and maintain training data diversity for efficient classification tasks [12]; and should identify datasets needed to train an AI system to achieve a set goal [1, 9, 12]) and the *Evaluation* stage (students should be able to train a model [11] and understand how biases in training data affect the accuracy and robustness of a machine learning model [1, 3, 9, 11, 14]).

Sporadically, frameworks refer to AI competencies pertinent at the following stages: *Modeling* (e.g., students should understand that computers construct representations using data [11]), *Process/Analysis* (students should train a model using clean, labeled data [3, 9]) and *Archiving* (students should be aware that personal data that is stored to facilitate the functioning of many AI systems raises concerns about user privacy, government surveillance, and data security [9]). AI-related competencies at the *Cleansing*, *Implementation*, *Optimization*, *Visualization*, *Sharing*, and *Erasing* stages are not covered at all in the currently available educational frameworks for AI literacy.

4 DISCUSSION AND CONCLUSION

The review results show that existing AI literacy frameworks either barely cover or do not cover competencies related to data literacy at all. Nevertheless, AI frameworks refer to several isolated competencies relevant to different stages of the data lifecycle and these findings support the thesis of [9], which states that AI literacy involves data literacy at multiple levels. Therefore, we argue that the frameworks must be expanded and should foster AI and data literacy more holistically. In doing so, the data lifecycle provides an entry point to reflect on AI competencies that are relevant to the data literacy context. For instance, creators of AI or data literacy frameworks may consider fostering AI-related skills such as extracting information from subject-specific data for further processing using AI tools (*Acquisition* stage); conducting efficient data sanitization and mitigating unfairness in datasets using AI methods (*Cleansing* stage); implementing concrete AI learning procedures and data management systems (*Implementation* stage); enriching data using AI techniques (*Optimization* stage); visualizing data using AI algorithms such as clustering (*Visualization* stage); generating new information from data using AI analysis methods (*Analysis* stage); explaining why results contain errors due to processing them with AI techniques and questioning such results (*Evaluation* stage); and using AI-driven procedures to optimize archiving, deletion or exchange of data (*Sharing*, *Erasing*, and *Archiving* stages). Such an approach might be taken into account when considering how to design future AI and data literacy frameworks, as well as interventions for comprehensive K-12 teacher education. In the future, we will empirically evaluate the effectiveness of the suggested approach for educating teachers of different subjects in AI and data literacy.

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