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Planning Interdisciplinary Artificial Intelligence Courses For Engineering Students

Johannes SCHLEISS
Otto von Guericke University Magdeburg, Germany, johannes.schleiss@ovgu.de

Sebastian STOBER
Otto von Guericke University Magdeburg, Germany, stober@ovgu.de

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PLANNING INTERDISCIPLINARY ARTIFICIAL INTELLIGENCE COURSES

J. Schleiss[1]
Faculty of Computer Science, Otto von Guericke University Magdeburg
Magdeburg, Germany
0009-0006-3967-0492

S. Stober
Faculty of Computer Science, Otto von Guericke University Magdeburg
Magdeburg, Germany
0000-0002-1717-4133

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ABSTRACT

As Artificial Intelligence (AI) becomes increasingly important in engineering, instructors need to incorporate AI concepts into their subject-specific courses. However, many teachers may lack the expertise to do so effectively or don't know where to start. To address this challenge, we have developed the AI Course Design Planning Framework to help instructors structure their teaching of domain-specific AI skills. This workshop aimed to equip participants with an understanding of the framework and its application to their courses. The workshop was designed for instructors in engineering education who are interested in interdisciplinary teaching and teaching about AI in the context of their domain. Throughout the workshop, participants worked hands-on in groups with the framework, applied it to their intended courses and reflected on the use. The workshop revealed challenges in defining domain-specific AI use cases and assessing learners' skills and instructors' competencies. At the same time, participants found the framework effective in early course development. Overall, the results of the workshop highlight the need for AI integration in engineering education and equipping educators with effective tools and training. It is clear that further efforts are needed to fully embrace AI in engineering education.

[1] *Corresponding Author*
J. Schleiss
johannes.schleiss@ovgu.de

1 MOTIVATION AND LEARNING OUTCOMES

Tools and methods of Artificial Intelligence (AI) are becoming more and more important in the engineering practice. This also requires instructors to integrate AI as content in their domain-specific courses. In this context, AI education often goes beyond basic AI competencies and capabilities (often referred to as AI literacy). It also goes beyond what can be framed as consumer AI, for example currently in hype generative large language models, and focuses on industrial AI. Rather, students should learn how to work with and apply industrial AI in their specific subject or even develop domain-specific solutions themselves (Schleiss et al. 2022a). However, this presents a challenge for teachers who may not be computer scientists themselves, and who may not have expertise in AI. To address this problem, we have developed the *AI Course Design Planning Framework* (Schleiss et al. 2023) to help instructors structure and design their teaching of subject-specific AI skills.

This workshop aims to promote the ability of instructors to teach domain-specific AI skills in a structured and effective manner. After the workshop participants can:

- distinguish between AI literacy and more advanced AI competencies
- understand important categories and leading questions for developing domain-specific AI courses using the framework
- apply the AI Course Design Planning Framework for their own course and discipline context

2 TEACHING ABOUT ARTIFICIAL INTELLIGENCE IN ENGINEERING EDUCATION

Interdisciplinarity gains relevance in engineering education (Van den Beemt et al. 2020). This also includes bridging the gap between disciplines and integrating methods from other fields in the teaching offers. In this context, education about AI is domain-specific, and means teaching AI as a method in a certain domain context. An example can be the use of AI methods for sustainability in terms of process improvements or energy optimization (Van Wynsberghe 2021).

This interdisciplinary approach to AI education aims to resemble real-world problem-solving and motivate students through relevance (Lindvig and Ulriksen 2019; Janssen et al. 2020). At the same time, domain-specific AI education requires a good understanding of the background, and prior experiences of students (Ng et al. 2022). Moreover, instructors themselves often combine their domain expertise with the topic of AI, which requires self-reflection on their own competencies and role in the learning process (Kim et al. 2021; Ng et al. 2023).

Some examples of teaching AI in an engineering education context have tested a practice-based learning approach using a combination of projects and OER (Schleiss et al. 2022b) or a modular approach for learning paths that involve different depth and content depending on the target group in an industry setting (Salazar-Gomez et al. 2022). With the rapid development of AI technology, it is apparent that there is a need for a structured approach to AI course development at the intersection of AI and the engineering domain that allows educators to reflect their current courses with their respective learning outcomes, assessments and activities, and assess if they want to integrate new perspectives based on the development and use cases around AI in their domain context.

3 WORKSHOP DESIGN

The workshop was organized as an interactive session in which participants were invited to actively contribute their experiences and insights in all the workshop segments. Moreover, throughout the workshop, participants applied the AI course design planning framework (see Figure 1) to their intended courses and reflected in small groups on its potential strengths and weaknesses.

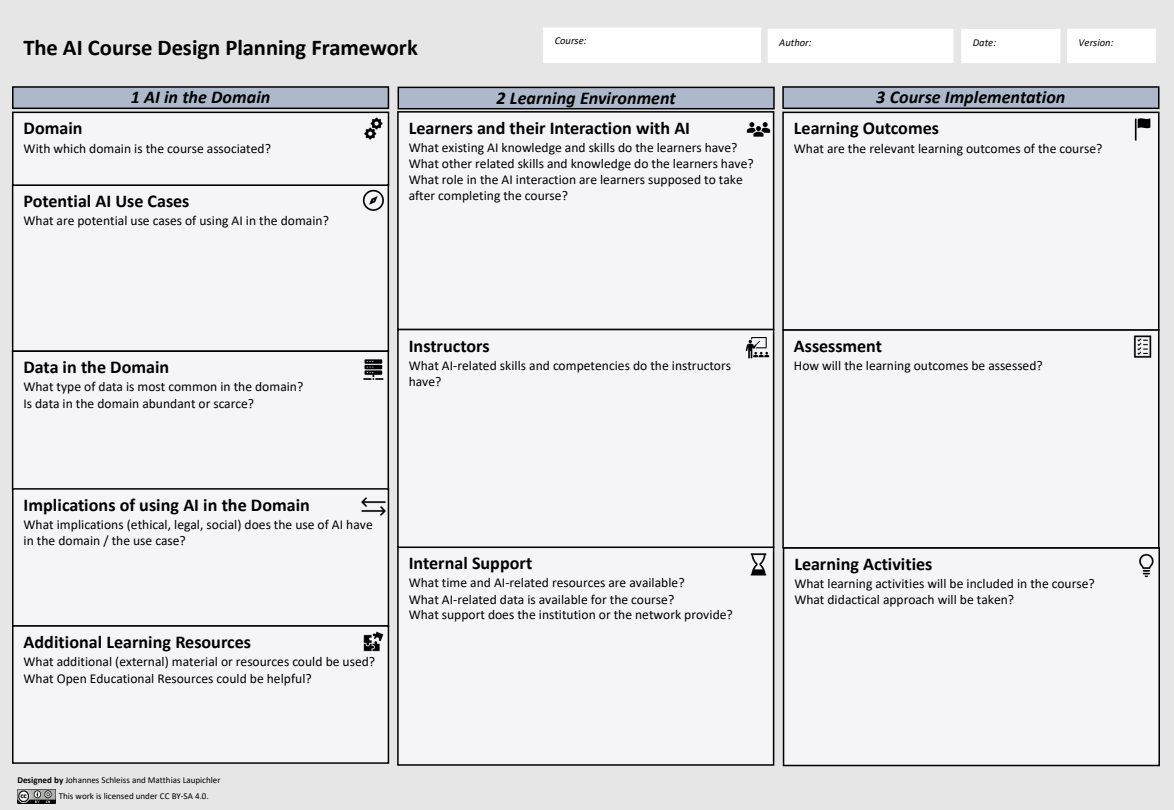

Fig. 1. The AI Course Design Planning Framework (Source: Schleiss et al. 2023). A blank version is also available via https://education4ai.github.io/ai-course-design-planning-framework/ (Accessed 21.09.2023).

Workshop Structure

The workshop was structured as follows:

- **Introduction:** Interactive presentation to AI competencies and the AI Course Design Planning Framework (15 minutes)
- **Group Work:** Developing courses with the AI Course Design Planning Framework in a collaborative group activity with groups of 3-5 people (30 minutes)
- **Reflection:** Sharing outcomes of the group activity and evaluating the use of the AI Course Design Planning Framework as a development framework and working out possible improvements (10 minutes)
- **Conclusion:** Collective summary of experiences in the group activity (5 minutes)

Target Audience

The workshop was designed for instructors in engineering education who are interested in interdisciplinary teaching and teaching about AI in the context of their domain. A basic understanding of AI was sufficient to attend the workshop. At the

same time, the workshop did not dive deep into explaining AI technology but will focus on the competencies and considerations that need to be taken when planning an AI course.

4 RESULTS OF THE WORKSHOP

In the workshop, the 35 participants split into six groups and used the AI Course Design Planning Framework for an exemplary chosen course. While the time given to work with the framework allows a first start, it is usually not enough to complete filling it out within a limited timeframe of 30 minutes. In working with the framework, the following observations, experiences and difficulties were identified.

First, multiple groups had difficulties in defining potential AI use cases in the context of their domain, which some grounded in a lack of knowledge and skills in industrial AI from an educator perspective. This was also supported by the observation, that four out of six teams used use cases involving large language models, which could be categorized more as consumer AI. Some participants highlighted that they would have found it helpful to build upon existing use cases and examples.

Second, scoping the learners' skills and backgrounds was perceived as difficult, especially considering the AI perspective. It was mostly unclear for educators how much students use, for example, consumer AI and what can be drawn from these insights. Accordingly, there were not always insights into the competencies of instructors, especially in bigger course settings with multiple instructors.

Last, one group discussed the category of implications of using AI in the domain and mentioned that the environmental implication could be an addition.

Overall, participants highlighted the simplicity of the framework and that it allows for quick iteration in course development, especially in earlier development phases. They also found it easy to work with the right part of the canvas, which corresponds to classical course planning frameworks.

Multiple people indicated their interest in the materials and to potentially participate in follow-up research studies.

5 CONCLUSIONS

With the rapid advancement of the field of AI, it becomes more and more important to integrate teaching about AI in the respective curricula and courses. The primary objective of the workshop was to support instructors in familiarizing themselves with possible AI competencies in their respective domains and to provide them with the tools to develop domain-specific AI courses.

The outcomes of the workshop underscored the efficacy of the AI Course Design Planning Framework as a valuable and user-friendly resource for course development and discussion. At the same time, it was apparent that there was a lack of knowledge in industrial AI that hindered the participants to fully embrace and utilize the framework.

These findings underscore the critical necessity for enhancing educators' competencies in AI. This also extends beyond merely addressing consumer-oriented AI applications within their teaching to the integration of relevant industrial AI use cases into the learning outcomes (Schleiss et al. 2023). In addition to providing comprehensive teacher training, the creation of a database featuring examples of

existing courses could catalyze further development in this field. Furthermore, the aspect of (self-) assessment of AI competencies of students and teachers is a topic of need, similar to proposed in (Laupichler et al. 2023).

This workshop increased awareness and built a foundation for advancing the integration of AI topics and competencies into engineering education. At the same time, it also made clear that there is still some work to be done to fully embrace AI in engineering education.

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