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Enhancing AI literacy of educators in higher education

Abstract

As AI becomes integral to students' learning, educators must adapt to this AI-driven landscape. However, there is a notable gap in research focusing on fostering AI literacy among higher education lecturers. This paper presents a design-based research project aimed at developing a professional development curriculum for educators at the tertiary level through iterative cycles. In the first cycle, a voluntary internal professional development course was offered as a blended learning scenario. Evaluation involved a validated AI literacy performance test and AI readiness scale items. The

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results of the first cycle are going to be presented and discussed. Based on these findings, modifications to the course are outlined.

Keywords

artificial intelligence, future skills, AI readiness, design-based research

Verbesserung der KI-Literacy von Lehrenden im Hochschulbereich

Zusammenfassung

Da KI zum integralen Bestandteil des Lernens der Studierenden wird, müssen sich die Lehrenden anpassen. Es mangelt jedoch an Forschung zur Förderung von KI-Literacy bei Hochschullehrenden. In diesem Beitrag wird ein designbasiertes Forschungsprojekt vorgestellt, das darauf abzielt, in iterativen Zyklen ein Curriculum für die berufliche Weiterbildung von Lehrenden im Hochschulbereich zu entwickeln. Im ersten Zyklus wurde ein freiwilliger interner Weiterbildungskurs in Form eines Blended-Learning-Szenarios angeboten. Die Evaluierung umfasste einen validierten KI-Leistungstest und Items einer KI-Bereitschaftsskala. Die Ergebnisse des ersten Zyklus werden vorgestellt sowie diskutiert und auf dieser Grundlage wird die Kursüberarbeitung skizziert.

Schlüsselwörter

Künstliche Intelligenz, Future Skills, KI-Bereitschaft, Designbasierte Forschung

1 Introduction

Artificial Intelligence (AI) is significantly impacting various facets of higher education, including teaching, research, administrative tasks, and student learning experiences. For instance, current research (Nikolopoulou, 2024) discusses how AI can enhance pedagogical practices in higher education. As AI continues to advance rapidly, universities are compelled to become more adept at leveraging AI to stay relevant in the educational sector (Rütti-Joy et al., 2024). Hence, higher education institutions must adapt to the changing landscape of AI in education by fostering a comprehensive understanding of AI-related tools, establishing clear policies, and addressing ethical concerns to leverage the full potential of AI in enhancing teaching and learning experiences.

Several scholars (Maznev et al., 2024; Rütti-Joy et al., 2023) highlight the importance of professional development (PD) regarding AI literacy for lecturers at the tertiary level. However, there is a gap in the development of an AI literacy competency framework specifically tailored for higher education. While there have been efforts to propose AI literacy frameworks for various educational levels, especially secondary education (Casal-Otero et al., 2023), there is a lack of a comprehensive framework and training designed specifically for educators at higher education institutions.

To address the aforementioned gap, we present in this paper a design-based research (DBR) project aimed at contributing to practice as well as theory of AI literacy in higher education. On the one hand, we are developing a curriculum for a PD course concerning AI literacy, including the didactical scenario and resources. On the other hand, we are further developing a general AI literacy competency framework (Long & Magerko, 2020) to tailor it to the needs of educators at the tertiary level. The presented research project is still ongoing and in this paper the results of the first DBR cycle are described and discussed.

2 Theoretical background

This section provides an overview of the theoretical foundation of our research. It includes the chosen definition of AI literacy and AI readiness, the selection of an appropriate AI literacy competency model, and the instructional approach utilized for developing the didactical scenario. In the end of this section the research questions are outlined.

2.1 AI literacy definition

In this research we are using the established AI literacy definition of Long and Magerko (2020), which has been widely used in other studies (e.g. Hornberger et al., 2023). Long and Magerko (2020, p. 2) 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".

2.2 AI readiness definition

For the concept of AI readiness we are referring to Karaca and colleagues' (2021) scale since it was developed and validated in an educational setting. Karaca and colleagues (2021) established a comprehensive scale for understanding AI readiness, which is structured around four components: cognition, ability, vision, and ethics. Cognition encompasses the knowledge necessary to engage with AI technologies effectively. Ability pertains to the practical skills required to implement and utilize AI systems. Vision involves the foresight as well as understanding the strengths, limitations, opportunities and challenges of AI. Ethics addresses the moral considerations and responsibilities associated with the use of AI.

2.3 AI literacy competency model

In the beginning of our research process, we conducted a literature review to evaluate different competency models for AI literacy. Among the models reviewed, we decided to use the competency model for AI literacy proposed by Long and Magerko (2020). The decision to adopt this competency model was driven by several key factors. Firstly, the model's foundation is solidly rooted in the literature, with each competency supported by relevant academic sources. This thorough grounding ensures that the competencies identified are both relevant and essential for understanding AI. Secondly, the extensive citation of Long and Magerko's work in subsequent research underscores the model's influence and acceptance within the academic community. Furthermore, there is a notable gap in the existing literature regarding competency models specifically tailored for lecturers. While various models address AI literacy for students (e.g. Touretzky et al., 2023), a dedicated framework for educators at the tertiary level is lacking. By adopting Long and Magerko's model, we aim to bridge this gap by further developing their competency model and tailoring it to the target group of lecturers.

Long and Magerko's competency model for AI literacy is a comprehensive framework designed to equip individuals with the skills necessary to interact with, understand, and critically evaluate AI technologies. The model is structured around five main themes, namely 1) What is AI?, 2) What can AI do?, 3) How does AI work?, 4) How should AI be used?, 5) How do people perceive AI?. Each main theme encompasses specific competencies and design considerations for setting up AI literacy programs. In total the model comprises 17 competencies and 15 design considerations.

2.4 Tell Show Enact Do approach

The Tell Show Enact Do (TSED) instructional model is based on the Synthesis of Qualitative Data (SQD) model (Tondeur et al., 2012), which provides an overview of effective strategies for supporting educators in learning about technology.

In the TSED model, these conceptual strategies are merged with concrete learning events (Merrill, 2018) resulting in a practical solution for putting the SQD model into practice. In the tell (T) learning event, educators learn theoretical and conceptual information about a specific technology. As recommended in the SQD model, theory needs to be aligned with practice. Thus, telling is followed by a show (S) learning event in which the practical application of theory is demonstrated to the educators. Further, if possible, instructors should use examples from their own practice to also fulfill the role model strategy. Opportunities intended to engage educators in authentic experiences are described as enact (E) learning events. In such events, educators literally enact the taught content of a course by experiencing technologies from the perspective of learners (Buchner & Hofmann, 2022) and/or from the perspective of a teacher (Schallert-Vallaster et al., 2024). Finally, in the do (D) learning event, educators plan and prepare a technology-enriched lesson in small groups (collaboration and instructional design strategy). Subsequently, the lesson is presented, and feedback is obtained (feedback strategy). Additionally, reflection is undertaken on the planning process and the potentials and challenges of technology for the purpose of teaching and learning (reflection strategy).

In previous studies, the TSED model has shown to be effective for learning how to integrate augmented and virtual reality into classroom teaching (Buchner & Hofmann, 2022). However, more research is needed to explore if the model is also effective for learning about other technologies like AI. Thus, using the TSED model within this research project can enhance empirical knowledge about its effectiveness, but this is not the focus of the current paper.

2.5 Research questions

In this paper the following research questions are tackled.

1. To what extent does the proposed curriculum foster AI literacy among the participating lecturers?
2. How does participation in the PD course impact lecturers' AI readiness in terms of cognition, ability, vision, and ethics?

3 Methodological framework

In this section, we present the methodological framework guiding our study, beginning with an overview of DBR. We will discuss the principles of DBR and elaborate on how these are adopted and adapted to fit the specific needs of our research. Following this, we describe the context and participants of the study. Finally, we outline the instruments that will be employed to collect and analyze data.

3.1 Design-based research

The set up methodological framework is anchored in the principles of DBR, which is characterized by being (1) pragmatic, (2) grounded, (3) interactive, iterative, and flexible, (4) integrative and (5) contextually based (Wang & Hannafin, 2005).

In our research, we utilize the five main characteristics of DBR as a robust framework for developing and refining an educational intervention. First, our approach is pragmatic, aiming to contribute simultaneously to the theoretical development and practical improvement. The foundation of our curriculum design is the AI literacy competency model by Long and Magerko (2020), which provides a comprehensive model for AI literacy and the design is applied in an educational setting. Our research project is interactive, iterative, and flexible, because the design is collaboratively developed with content experts and practitioners in iterative cycles of analysis, design, implementation and redesign. To be more specific, one research cycle includes

multiple phases: literature review, collaborative curriculum design, data collection, data analysis and revision of the curriculum based on the results (see Figure 1 for overview of the first DBR cycle). This approach ensures that the curriculum is both theoretically sound and practically applicable. Furthermore, our approach is integrative, utilizing various research methods and instruments throughout the research process. However, with an evolving research process the used methods and instruments may vary. To meet the fifth characteristic of DBR, our approach is contextually based as we document the entire research (e.g. necessary adjustment to the initial design), and the developed curriculum and design principles are based on our specific environment.

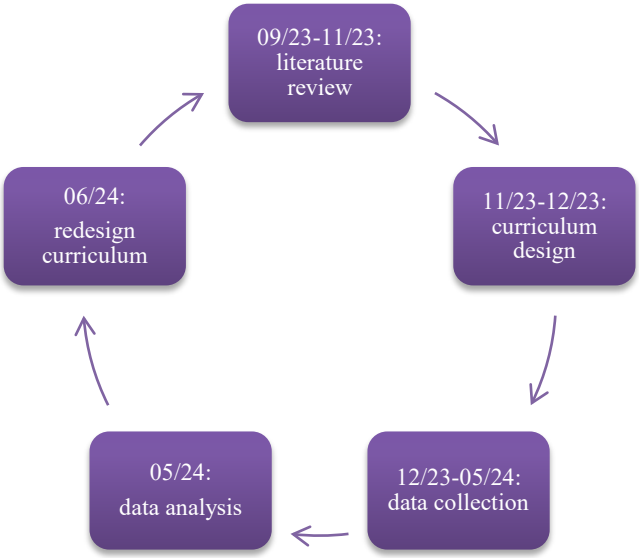

Fig. 1: Phases and timeline of the first DBR cycle

3.2 Context and participants

This DBR project is conducted at the St. Gallen University of Teacher Education. In the first DBR cycle, 22 teacher educators participated in the PD course on the topic of AI literacy[7]. The participants were heterogenous, e.g. in terms of prior knowledge of AI, the subjects they taught, and their teaching experiences in various degree programs. With their different teaching experiences in higher education and their pedagogical knowledge, participants can contribute with their feedback to the refinement of the course.

3.3 Instruments

A combination of two instruments is utilized in this DBR project to gather sufficient information for the redesign of the curriculum. In the first DBR cycle the AI literacy performance test validated by Hornberger et al. (2023) is a central instrument. This multiple-choice test with 30 questions is applied in a pretest-posttest design and based on the competence model of Long and Magerko (2020). It was developed in English and German to quantitatively measure the AI literacy of the participants, thus providing a clear metric for the curriculum's effectiveness. However, Hornberger et al. (2023) decided to exclude the two competencies (*Action & Reaction, Sensors*) that focus only on one aspect of AI, namely robotics. Additionally, they excluded the competency titled *Imagine Future AI* as it is not possible to assess predictions through a performance test. Hence, we decided to include in our study the 18 items of an AI readiness scale (Karaca et al., 2021) to assess the preparedness, perceptions and attitude of the participants regarding incorporating AI into education, using a five-point Likert scale to capture their responses.

We translated the abovementioned items of the AI readiness scale from English to German by employing a back translation approach. Furthermore, a native speaker checked our translation, and we pilot tested the translated items with 158 teachers in

7 11 participants did not finish the course due to different reasons: underestimated workload, voluntary course, cancellation free of charge.

another research project. With the data collected through the pilot testing we calculated the Cronbach's alpha values for each construct (AI readiness: Cognition: 0.87, Ability: 0.92, Vision: 0.79, Ethics: 0.8) and did not change any items based on these values. Due to the translation and pilot testing phase, we could include the AI readiness items only in the posttest. However, in subsequent cycles we could use these items in a pre- and posttest to detect changes regarding the participants' AI readiness.

4 Characteristics of the professional development course

4.1 Learning objectives

The learning objectives of the PD course are comprehensive. Starting with an understanding of the basic concepts of AI and how it works, participants will explore different applications of AI in the context of education. This basic knowledge is complemented by critical discussion and analysis to assess the potential benefits and risks associated with the use of AI in higher education. Participants will implement selected AI applications in their own teaching environments. Based on their experiences and discussions with peers, they draw meaningful conclusions for the future implementation of AI in higher education.

4.2 Instructional approach and content

As shown in Figure 2, the TSED instructional model is embedded in a blended learning scenario. According to this flexible learning approach, on the one hand, the participants will be able to tailor the learning process to their individual needs (Müller et al., 2019), while on the other hand, the potential benefits and risks associated with the use of AI and the one's own experiences using AI in higher education can be discussed in depth in on-site events. For setting up the content, a literature review

was conducted to identify key concepts that have been integral to the success of similar programs in this domain. The course content is aligned with the competencies regarding AI literacy outlined by Long and Magerko (2020). A detailed presentation of the course content and the addressed competencies can be found in Schallert-Vallaster et al. (2024).

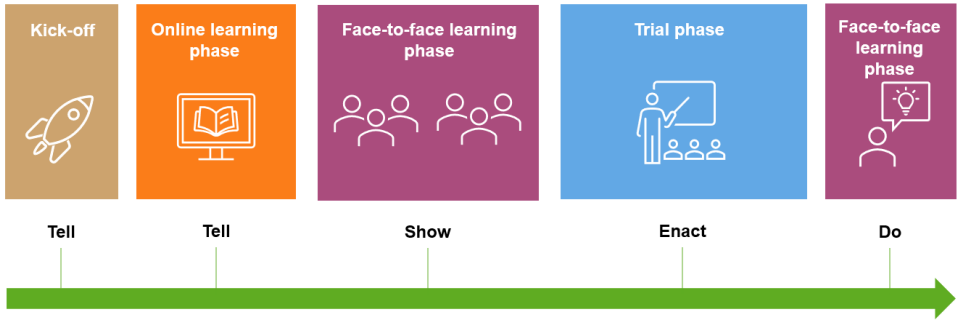

Fig. 2: Instructional approach

In the tell learning event, the different prior knowledge of the participants and the varying workload of university teachers during the semester suggests that participants can work on the course materials flexibly, according to their needs and independently of time. Participants are expected to invest about eight hours in a self-study program which includes a wide range of educational materials such as instructional videos, in-depth textual content, and interactive websites.

At the beginning of the show learning event (on-site day-event), participants' questions on the topics presented in the self-study program are answered. Participants can then deepen their knowledge by choosing from a range of workshops on different topics offered by various AI experts. Experts demonstrate various AI tools and challenge participants to use the tools in their own field of application. By sharing their experiences with the other participants, the first conclusions are drawn for use in higher education.

The enact and do learning events are closely linked with each other and focus on gaining and sharing authentic experiences of using AI in participants' higher education teaching contexts. The enacting phase takes place over several months, allowing participants to select relevant and appropriate ways of using AI in their own courses. The final half-day on-site event will focus on peer feedback on the lessons presented and will address selected issues related to the future implementation of AI in higher education.

5 Results

In the following section we outline the results concerning AI literacy and AI readiness, detailing the results for each construct respectively.

5.1 Description of results regarding AI literacy

The comparison of pretest and posttest results across various AI competencies reveals interesting results regarding participants' knowledge and understanding (see Figure 3). Notably, the competency of *Machine Learning Steps* saw the most substantial gain, with nearly 60% of participants answering correctly in the posttest, compared to just over 25% in the pretest. This indicates a significant enhancement in participants' ability to comprehend the different steps of machine learning, including the specific practices and challenges associated with each step. Regarding the competency of *Decision-Making*, posttest results were around 44%, up from about 26% in the pretest marking a notable improvement. Similarly, regarding the competency titled *General vs. Narrow,* the posttest results were around 44%, compared to pretest scores of about 24%. Despite the notable improvement concerning the competencies of *Decision-Making* and *General vs. Narrow*, the overall percentage of correct answers remains relatively low, suggesting that participants still struggle with these competencies. Another competency showing considerable improvement include *Human Role in AI*, with posttest scores around 56%, up from pretest scores of approximately 42%.

In terms of ethical considerations concerning AI, there was a marginal improvement, with posttest results reaching approximately 64%, compared to about 61% in the pretest. Also, participants performed slightly better in *Data Literacy, Learning from Data* as well as *AI's Strengths and Weaknesses*.

The results of the participants in the posttest were slightly worse compared to the pretest concerning the competencies of *Recognizing AI*, *Interdisciplinarity*, *Understanding Intelligence*, and *Programmability*. However, with all these competencies more than half of the participants answered the associated items correctly.

While the PD program successfully improved participants' knowledge and understanding regarding various AI competencies, certain competencies still require further enhancement. Specifically, the competencies of *Representations*, although showing a slight improvement, and *Critically Interpreting Data* indicate room for further development.

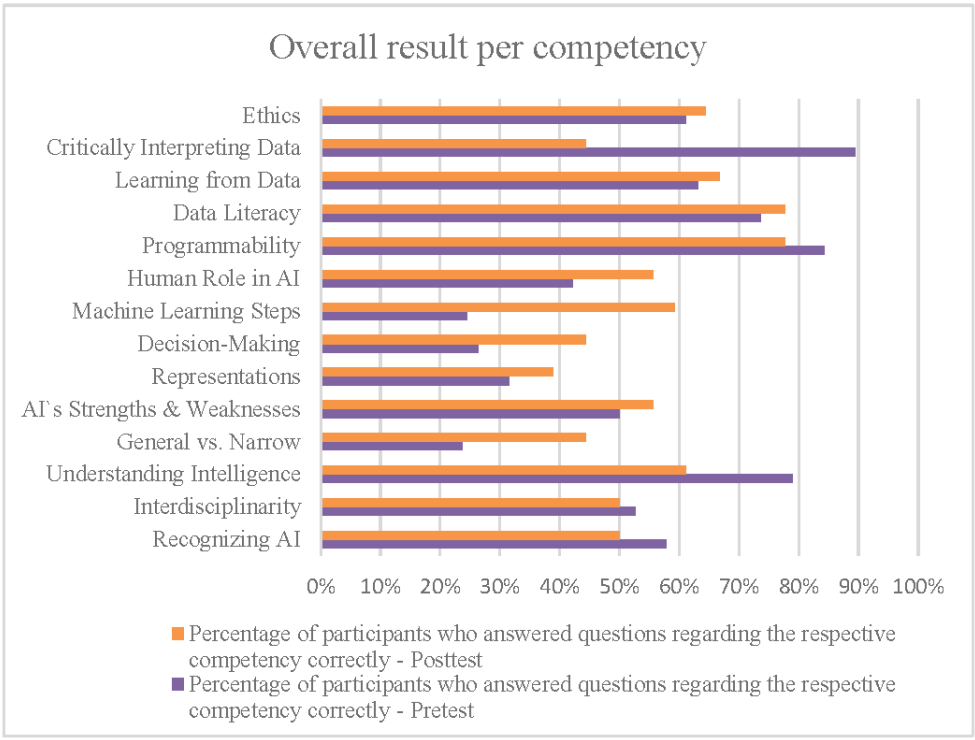

Fig.3: Comparison of pretest and posttest results

5.2 Description of results regarding AI readiness

Among the various findings concerning AI readiness, the most notable results of the components cognition, ability, vision and ethics, which constitute the construct of AI readiness, are highlighted below.

Cognition: The average response (M = 2.9) for the item "I can effectively balance the relationship between teachers and AI technologies" is just below neutral, indicating a slight tendency towards disagreement. The low standard deviation of 0.5

suggests that there is a high level of agreement among respondents about their slight disagreement or neutrality. However, most participants, on average (M = 4.2, SD = 0.4), strongly agree that AI technologies are important for data collection, analysis, evaluation, and security in education.

Ability: While the mean with 2.8 of the item "Based on the visual and real-time feedback provided by AI technologies, I can improve my teaching in the next step" is close to neutral, it slightly leans towards disagreement. This means that most respondents (SD = 0.6) do not strongly agree or strongly disagree but are slightly more inclined to disagree. Nevertheless, lecturers feel on average (M = 3.7) confident in their ability to collaborate with peers on the use of AI technologies to design teaching solutions. While most lecturers share this confidence, there is a moderate range of opinions (SD = 0.6), suggesting that some lecturers may feel more or less confident than others.

Vision: The results indicate that respondents generally agree with the statement "I have my own unique thinking and views on how to improve and use AI technologies for education," as reflected by a mean score of 4.0. The low standard deviation of 0.4 suggests that this agreement is consistent among respondents. Similarly, for the item "I foresee the opportunities and challenges that AI technologies entail for education," the mean score of 3.8 and standard deviation of 0.4 indicate that respondents agree with this statement as well, with a consistent level of agreement across the group.

Ethics: For the item "I understand the digital ethics that teachers should possess in the era of AI," the results show a mean score of 3.7 and a standard deviation of 0.5. This indicates that participants generally agree with the statement. The moderate standard deviation implies that while there is some variation, most respondents have a similar level of understanding regarding the importance of digital ethics in the context of AI. Despite this result, the results for the item "I know how to keep personal information safe when using AI technologies" indicate a mean score of 2.5, suggesting that respondents are generally neutral or slightly disagree with the statement. The standard deviation of 0.8 reveals considerable variability in responses, indicating that

there is a significant range in the level of confidence or knowledge among respondents regarding data privacy and security when using AI technologies.

6 Discussion

Based on the presented results, this section aims to answer the posed research questions and discusses the changes made to the PD course.

6.1 To what extent does the proposed curriculum foster AI literacy among the participating lecturers?

The proposed curriculum aims to foster AI literacy among participating lecturers by addressing the five main themes of AI literacy (Long & Magerko, 2020) outlined in the theoretical background of this paper. Firstly, the curriculum covers the fundamentals of AI, including the competencies *Recognizing AI*, *Understanding Intelligence*, *Interdisciplinarity*, and *General vs. Narrow*. This area shows a need for improvement as lecturers' understanding was limited (even posttest results were slightly worse) and only the results regarding the competency of *General vs. Narrow* were in the posttest better. The slightly poorer results in the posttest could indicate that the first version of our course generates a misleading picture of what AI is. Secondly, the curriculum explores AI's capabilities, emphasizing the competency *AI's Strengths and Weaknesses*. Here, lecturers performed reasonably well, with only slight improvements observed post-intervention. Thirdly, the curriculum discusses how AI works, encompassing the competencies *Representations*, *Decision-Making*, *Machine Learning Steps*, *Human Role in AI*, *Data Literacy*, and *Critically Interpreting Data*. Significant improvements were noted in most of these competencies, particularly in understanding *Machine Learning Steps* and *Decision-Making*, although there is still room for further enhancement concerning the competencies *Representations*, *Decision-Making* and *Critically Interpreting Data*. The posttest results for the competency *Critically Interpreting Data* were lower than in the pretest, suggesting that the information presented in the course may have been misunderstood.

Fourthly, the curriculum addresses the ethical use of AI, an area where lecturers already demonstrated good understanding, with only minor gains post-intervention. Lastly, the curriculum examines how people perceive AI, focusing on the competency of *Programmability*. This competency was already well grasped by the lecturers before participating in the PD course.

When revising the course content, we aligned our focus with the results from the AI literacy performance, emphasizing the competencies of *Recognizing AI, Interdisciplinarity, General vs. Narrow, Decision-Making*, *Representations* and *Critically Interpreting Data*. For instance, to enhance understanding concerning the competency *Recognizing AI*, we introduced more concrete examples of AI at the beginning of the course and incorporated an online exercise designed to help participants determine whether a given example is AI or not. To address the other competencies, we inserted the course content into a gamified learning app (see https://brian.study/en/), which accompanies our online course. This app, powered by an AI teaching assistant, creates an engaging learning environment by including adaptive quiz questions tailored to the learners' needs.

6.2 How does participation in the PD course impact lecturers' AI readiness in terms of cognition, ability, vision, and ethics?

Based on the results, most participants recognize the potential and significance of AI in the current era. However, there was a slight tendency towards disagreement regarding the effective balance in the relationship between teachers and AI. To address this, we decided to include in-class discussions where participants could explore examples of how to create a harmonious and beneficial link between lecturers and AI in higher education. In the area of ability, we incorporated examples for the in-class discussions to demonstrate how real-time feedback from AI technologies can be utilized to enhance teaching in the subsequent steps. Since the competency *Imagine Future AI* cannot be assessed through the AI literacy performance test, the results in

the area of vision provide complementary insight by showing that participants foresee the opportunities and challenges that AI presents for education. Regarding ethics, we were surprised that most participants expressed uncertainty about safeguarding personal information when using AI and revised the course content to address this issue more thoroughly.

7 Conclusion and further research activities

The presented DBR project aims to enhance AI literacy among tertiary-level lecturers. Overall, the curriculum has been effective in enhancing AI literacy among lecturers in nine out of fourteen AI competencies, though certain competencies require additional focus and curriculum adjustments. To complement this, we utilized an AI readiness scale (Karaca et al., 2021). The findings in the area of cognition, ability and ethics lead to changes in the PD course.

According to the presented results of the first DBR cycle, we revised the curriculum and will reimplement as well as evaluate it in another cycle. The project will conclude with a tested but still adaptable curriculum that integrates research insights into practice, fostering ongoing innovation and long-term institutional integration. For example, the PD course serves as the foundation for a community of practice with regular meetings on AI topics and stand-alone webinars that are continually offered to reflect the latest AI developments, keeping lecturers equipped with up-to-date knowledge and tools.

As theoretical contribution the design principles for establishing PD initiatives aimed at improving AI literacy of Long and Magerko (2020) could be adapted for higher education contexts and should be examined through additional cycles of research. These principles could then be disseminated and validated in diverse educational contexts.

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