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How Do AI Educators Use Open Educational Resources? A Cross-Sectoral Case Study on OER for AI Education

RESEARCH ARTICLE

FLORIAN RAMPELT
RAFFAEL RUPPERT
JOHANNES SCHLEISS
DANA-KRISTIN MAH
KATHARINA BATA
MARC EGLOFFSTEIN

*Author affiliations can be found in the back matter of this article

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ABSTRACT

Artificial Intelligence (AI) literacy is essential for society as a whole. While general frameworks and resources to support self-directed learning on AI are widely available, research on how to support AI educators, particularly those without AI expertise (non-experts), using external materials and resources is relatively scarce. This article explores the potential of open educational resources (OER) to enhance AI education, with a specific focus on the requirements and practices of AI educators. Through a case study of the AI Campus learning platform, the article examines how educators from diverse sectors such as school education, higher education and professional education utilise OER for AI education. The study aimed to identify patterns of OER usage, AI educator motivations and the sector-specific integration of OER into teaching practices. A survey study of 260 educators from Germany, Austria, and Switzerland using AI Campus content revealed that educators prefer smaller, modular OER formats and value suitable, high-quality and accessible content. The reputation of the person or institution that created the OER content does not seem to play a major role. Sector-specific differences could be observed in particular with regard to full online courses, face-to-face learning scenarios and the AI learning objectives of an educator. By focusing on educators' perspectives, the study provides insight into how AI education can be strengthened across sectors through the use of OER materials and ultimately benefit learners through suitable, high-quality content and adequate AI learning scenarios.

CORRESPONDING AUTHOR:
Florian Rampelt
Stifterverband für die Deutsche Wissenschaft e.V., Germany
florian.rampelt@stifterverband.de

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1 INTRODUCTION

Artificial intelligence (AI) is considered a key technology of the present and future. It is 'transforming our world' (United Nations, 2024, p. 7), permeating both private and professional lives (Ipsos, 2024). For the education sector, the current developments in the field of AI highlight a continuous need to adapt to changing knowledge and skill requirements to avoid social and economic upheaval. Goldin and Katz (2008) described this phenomenon as a 'race between education and technology' (p. 287). While previous development leaps were slower and more protracted, the advancement of AI has been rapid affecting almost every professional discipline. In Europe, AI literacy will become increasingly important given the implementation of the AI Act, which requires a 'sufficient level of AI literacy of their staff and other persons dealing with the operation and use of AI systems' (European Union, 2024, Article 4). This includes educational institutions and everyone using AI systems within them. From an educational perspective, the current developments clearly show that stakeholders in formal educational settings need to deal with AI not only in the traditional information technology (IT) departments or the computer sciences but in relation to all disciplines affecting a wide variety of learners. AI literacy for all will most likely be one of the key challenges of the coming decade.

However, a significant challenge for education systems is that most educators are not AI experts and show an 'insufficient knowledge of AI technologies' and 'weak self-efficacy' (Chiu et al., 2023, p. 12). To address their knowledge and skill gaps, educators and teachers often need to educate themselves and rely on knowledge, resources and materials outside their institution to provide their learners with relevant content and adequate approaches to the use and critical appraisal of AI technologies. In particular, the question arises as to how teachers can access knowledge, resources and support to address this new topic when textbooks, curricula and their own institutions have yet to make them available.

The discussion on digital competencies and skills in general, as well as more specific concepts of data and AI literacy in particular, has seen much engagement and many frameworks have been published in recent years (Laupichler et al., 2023; Long & Magerko, 2020; Schüller et al., 2019, 2023). In 2024, UNESCO published an AI competency framework targeting (K–12) 'teachers who need to apply AI to facilitate learning in core subject areas' (UNESCO, 2024a, p. 14), and students (UNESCO, 2024b).

Regarding the 'hot topic' of AI, one should not forget that current discourse and an unseen number of publications have built on several decades of research on AI in education (Chen et al., 2022). Such research has primarily focused on AI as a tool, application or technology for improving educational processes (Bond et al., 2024; Chiu et al., 2023; Zawacki-Richter et al., 2019). Nevertheless, there are significant gaps in the research on how AI should be included in curricula and which educational resources and digital formats are particularly suited to support education about AI. A persistent research gap can also be observed in interdisciplinary research beyond sector boundaries such as K–12 or higher education (Bond et al., 2024; Schleiss et al., 2023). At the same time, there are still only tenuous links between the extensive research (Zawacki-Richter et al., 2020), practical developments (Shah, 2021) and political frameworks (UNESCO, 2019) in the fields of open education, open educational resources (OER) and AI education.

This article investigates the potential of OER to support (non-expert) AI educators and ultimately strengthen AI literacy for all. Building on Redecker (2017), we define the 'AI educator' as a person involved in the process of teaching AI or supporting the acquisition of AI literacy. This role refers to teachers at all levels of formal education and trainers in non-formal and informal settings. It should be noted that we explicitly refer to AI educators as individuals who teach AI regardless of whether their core expertise is in AI and computer science or entirely different disciplines.

To understand how AI-related digital education and the focus on educators' use of OER can contribute to the development of AI literacy in different educational contexts, we investigated the use case of the AI Campus (originally: KI-Campus), a Germany-based learning platform, that provides openly licenced and free access to educational resources on AI that include both self-produced content and external educational resources. Following a case study approach (Moore et al., 2023; Yin, 2015), we introduce the AI Campus as an approach to scaling AI

education for all, combining the potential of OER with the roles and needs of educators in practice. To do so, we conducted a survey study to investigate how educators integrate and use the digital formats of the AI Campus, which are almost all OER, in their AI education across different education sectors (K–12/ primary and secondary education, higher education/tertiary education, professional learning/continuing education). Within the context of the use case of the AI Campus learning platform, we focus on the following research questions (RQs):

RQ1: How do AI educators use OER in their teaching practices in different educational contexts?

RQ2: What are the drivers and motivations of AI educators in using OER?

RQ3: Are there connections between the education sector and a chosen format or learning scenario?

Based on initial findings from quantitative user surveys of AI Campus learners (Mah et al., 2023), a focused online survey was conducted among more than 250 educators from more than 200 different institutions in three different countries and various education sectors. With educators being enablers of AI education, this study contributes to the field of AI education by focusing on educator' perspectives. Therefore, the study provides an understanding of how educators use different types of OER in their AI teaching and highlights differences across the education sectors.

The paper is structured as follows: Section 2 provides an overview of relevant literature and the theoretical framework, addressing conceptual distinctions and recent developments in AI literacy and AI education. This section also highlights core principles of openness and OER and discusses instructional approaches for digital education. Section 3 focuses on the materials and methods, introducing the AI Campus as a case study as well as the data collection and analysis procedures. Section 4 presents the findings of the analysis with respect to the integration of OER, drivers for integration and other aspects. We conclude the paper by highlighting the main findings and providing an outlook for further research.

2 THEORETICAL BACKGROUND

2.1 AI LITERACY AND AI EDUCATION: WE ARE JUST GETTING STARTED

Research on AI education can currently be roughly divided into two dominant streams: (1) research that is particularly concerned with conceptual issues and trends relating to AI literacy or AI skills (i.e. education about AI) and (2) research that is particularly concerned with AI as a tool or application in education (i.e. education with AI). For example, in a meta-systematic review, Bond et al. (2024) equated AI in education with 'AI applications in education', which corresponds with other findings such as those of Chen et al. (2022). Although this seems understandable given the sheer volume of publications in this focus area over the course of several decades (Chen et al., 2022), a broader understanding of AI in education requires that we also focus on AI as content in teaching and learning. The basis for this is AI literacy, a term that emerged several years ago (Kandlhofer et al., 2016). Long and Magerko (2020) took this up and proposed a highly recognised AI literacy framework. They defined AI literacy as 'a set of competencies that enable 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' (Long & Magerko, 2020, p. 2). Laupichler et al. (2023) described AI literacy as 'competencies that include basic knowledge and analytical evaluation of AI, as well as critical use of AI applications by non-experts' (p. 1), or 'Technical Understanding, Critical Appraisal, and Practical Application' (p. 9). Almatrafi et al. (2024) conducted a systematic review of the conceptualisations of AI literacy and identified six key constructs: recognise, know and understand, use and apply, evaluate, create and navigate ethically. Bozkurt (2024) further defined AI literacy in the context of generative AI as 'the comprehensive set of competencies, skills, and fluency required to understand, apply, and critically evaluate AI technologies, involving [...] foundational knowledge (Know What), practical skills for effective real-world applications (Know How), and a deep understanding of the ethical and societal implications (Know Why)' (p. 285).

Researchers and policymakers alike have recognised the growing importance of AI literacy (Ifenthaler et al., 2024). In 2024, the European Union adopted its first common AI regulatory

framework. The Artificial Intelligence Act (European Union, 2024) states that 'AI literacy should equip providers, deployers and affected persons with the necessary notions to make informed decisions regarding AI systems' (p. 6) and defines AI literacy as the 'skills, knowledge and understanding that allow providers, deployers and affected persons [...] to make an informed deployment of AI systems, as well as to gain awareness about the opportunities and risks of AI and possible harm it can cause' (p. 49).

As the result of both research and a public consultation process, UNESCO published an AI competency framework for schoolteachers (UNESCO, 2024a) and school students (UNESCO, 2024b). This framework 'distinguishes between four to five competency aspects at different progression levels. The focus is primarily on the position and influence of humans when dealing with AI systems, as well as ethical aspects. The basic understanding of the technology behind AI systems also comes into play' (UNESCO, 2024a, 2024b).

In summary, AI literacy as a concept and a responsibility for society as a whole has gained importance in recent years. Both research and policymaking emphasise the importance of a fundamental understanding of AI and AI systems, as well as the practical application of AI. Nevertheless, critical and ethical appraisal or evaluation seem to play a greater role in research and education than in general policies or implementation outside of the education sector.

In recognising AI literacy as a social and educational responsibility, there is a need to understand how to teach and learn it. A first summary of the literature on AI education as a broader concept was provided by Ng et al. (2023) in their systematic review on 'AI teaching and learning from 2010 to 2020', which focused on classroom-based pedagogical approaches and tools. Liu and Zhong (2024) conducted a systematic review on K–12 AI education, finding deficiencies in instructional design and curriculum development. Laupichler et al. (2022) investigated the topic of AI learning scenarios and teaching formats with a focus on online courses in the field of AI literacy and the higher education context. They concluded that 'many teachers do not know how to structure AI courses' (p. 13) or what content to include, highlighting that '[T]eachers and faculty should draw inspiration from other courses' (p. 13). In the context of Germany, digital learning opportunities have increased in recent years (Mah et al., 2020).

In summary, there have been various attempts to teach AI literacy. In particular, research has focused on AI education among K–12 students and less so on higher or further education (Crompton & Burke, 2023; Mah & Groß, 2024). There seems to be a general understanding of the growing importance of AI literacy in education, and there is a good body of research on the variety of available tools, learning scenarios and resources such as open online courses in individual sectors of education. At the same time, instructional design approaches and curriculum development are in their nascent stages.

2.2 OPENNESS, OPEN EDUCATIONAL RESOURCES (OER) AND MASSIVE OPEN ONLINE COURSES (MOOCs)

In the context of education, openness is a dynamic and multifaceted concept (Baker, 2017) involving aspects such as accessibility, flexibility, equity, collaboration, agency, democratisation, social justice, transparency and the removal of barriers (Zawacki-Richter et al., 2020). In short, 'openness in education refers to the idea that education should be accessible and available to everyone, regardless of socioeconomic status or other factors' (Koçdar et al., 2023, p. 1). Weller (2014) identified four main areas: open access (OA), open education [sic!] resources, MOOCs, and open scholarship. The implementation of OA, with its dimensions of open admission (concerning formal entry requirements or necessary prior knowledge) and open as free (concerning monetary costs) (Cronin, 2017), varies considerably among education providers and institutions. One major concept in the field of open education is OER. OER are defined by UNESCO (2019) as 'learning, teaching and research materials in any format and medium that reside in the public domain or are under copyright that have been released under an open license, that permit no-cost access, re-use, re-purpose, adaptation and redistribution by other' (p. 5).

The underlying pedagogical ideas of OER are reflected in the '5R activities' (retain, reuse, revise, remix and redistribute), which are, for example, formalised in the widely used Creative Commons licences (Wiley, 2015). The principles of open educational practices (OEP), which describe open

and collaborative pedagogical approaches in utilising or adopting OER (Ehlers, 2011; Klar et al., 2024) can result not only in a further dissemination of OER but also in innovations in open learning (Stracke et al., 2019). However, it remains difficult to 'single out the main drivers of OER adoption [...] [as] the use, reuse, adaptation, or creation of OER' (Klar et al., 2024, p. 348).

In recent years, MOOCs have emerged as a particularly prominent form of open education (Despujol et al., 2022) and potential OER adoption in different fields of education. MOOCs integrate the idea of openness with the concept of learning at scale. However, some argue that the actual principles of OER are hardly being implemented by many commercial MOOC providers (Wiley, 2015), and that various barriers to openness exist (Kögler et al., 2020). Moreover, the way MOOCs for learning at scale are often implemented as self-contained courses with few adaptation options could conflict with the regional needs of learners (Reich, 2020). As learners' individual and cultural backgrounds impact open online learning (Gameel & Wilkins, 2019), research indicates that adopting a one-size-fits-all approach to course design might not be appropriate (Rizvi et al., 2022, 2023). Using smaller, more manageable pieces of learning content from existing online courses such as MOOCs is known as modularising, which has been little studied so far (Egloffstein & Ifenthaler, 2023; Serth et al., 2022). However, globally, higher educational institutions have increasingly integrated MOOCs or other online courses into campus learning (Hendriks et al., 2024) or started to use just some parts or smaller digital formats or elements of online course content (e.g. videos) as part of their regular classroom instruction to create blended learning scenarios (de Jong et al., 2020). If these open online courses and their content are provided under open licences, they can be considered OER themselves. Thus, transforming comprehensive open online courses into smaller learning units or course components for blended learning could also be promising in the context of teaching AI, ultimately strengthening (open) educational practices in the context of AI literacy.

2.3 DIGITAL FORMATS AND LEARNING SCENARIOS

There is a certain lack of clarity regarding terminology used in education science; 'forms', 'formats', 'types', 'scenarios', 'modes', 'medium', 'models', 'approaches' and other terms are all used, sometimes synonymously, to describe how education and learning resources can be made available to learners. The term *format* in particular seems rather new in the digital learning and assessment context (Bandtel et al., 2021; Rampelt et al., 2022). It is generally understood as 'the way in which something is shown or arranged' or 'the way in which information is arranged and stored on a computer' (Cambridge Dictionary). In connection to multimedia learning, Clark (2014) described the instructional mode as 'the format in which information is displayed, such as text, graphics or audio' (p. 874). This understanding is also reflected in the UNESCO definition of OER (UNESCO, 2019).

Therefore, we define digital formats for learning as educational resources with a clear structure and instructional design that provide information and content to learners and can be embedded in different learning scenarios. These formats may vary in length and complexity depending on the learning objective (Rampelt et al., 2022). In the context of openness, digital formats can also reflect the previously described principles of OER.

The most prominent learning scenarios in education are face-to-face classroom instruction, online learning and blended learning (Singh et al., 2021). For example, the flipped classroom is a variation of blended learning, but with a specific order and purpose for both face-to-face and online learning (Schmid et al., 2023). Blended learning, characterised by a combination of online and face-to-face teaching and learning, offers a method to improve traditional educational models (Garrison & Kanuka, 2004; Graham, 2006). While research on the effectiveness of blended and hybrid learning is still emerging, several studies have shown that blended learning can lead to better student outcomes compared to both solely online or face-to-face formats (Boelens et al., 2017). Blended learning is therefore proposed to combine the 'best of both worlds' (Arbaugh, 2014). The benefits of blended learning include the flexibility, self-paced nature and cost-effectiveness of the online components, as well as the engaging and in-depth discussions this scenario can foster (Bernard et al., 2014; Ma & Lee, 2021; Vo et al., 2017). Simultaneously, the face-to-face elements aim to promote social learning, discussion and the practical application of knowledge (Buhl-Wiggers et al., 2023). However, the implementation of blended learning is not without challenges. These include difficulties in designing blended

learning courses (e.g. encouraging student interaction both face to face and online, fostering a flexible environment and creating an affective learning climate) (Boelens et al., 2017), adopting new technologies for creating and managing online courses (Lightner & Lightner-Laws, 2016) and producing high-quality educational resources such as online video content (Rasheed et al., 2020). In the post-pandemic period, many educational institutions have returned to traditional teaching (i.e. face to face), but the concept of blended learning appears to be a sustainable model, at least in higher education (Cobo-Rendón et al., 2022).

3 METHODS

3.1 CASE STUDY: AI CAMPUS – THE OER LEARNING PLATFORM FOR AI LITERACY

The AI Campus is a transnational digital learning platform that aims to promote AI literacy for all, with a focus on the Germany (D), Austria (A) and Switzerland (CH) (DACH) region, which are characterised by German-speaking majorities. The AI Campus collects educational resources (especially online courses, videos, podcasts and exercises/simulations) that others have developed and that are available free of charge (e.g. MOOCs on AI foundations or 'data literacy' video series), while also developing its own content ('AI Campus Originals') in German and English. All of this content is available for free and is mostly openly licenced as OER. The learning opportunities on the AI Campus are mostly available under the creative commons licence CC BY-SA 4.0 (Creative Commons, 2024). Since its launch, the AI Campus and its partners have curated and produced more than 100 open online courses and hundreds of other digital formats on different topics in the field of AI and data literacy. By November 2024, more than 1,500,000 individuals had visited the AI Campus, more than 250 openly licenced videos had been viewed on YouTube almost 3 million times in total and more than 70,000 people had registered with more than 25,000 certificates issued. Furthermore, 90% of the more than 500,000 instances of access to the learning platform in 2023 came from Europe.

Voluntary pre-course surveys on the platform conducted in 2023 (Flasdick et al., 2023) revealed that 14.53% of learners (N = 11.938) planned to apply the acquired knowledge and resources in their own teaching. This underlined the need to explore the perspectives of the target group of educators who are currently underexplored in research. In particular, this study focuses on understanding how educators use and integrate OER in their teaching and learning, identifying their motivations and drivers and trying to understand if there is a link between the education sector and the chosen resource, learning scenario or format.

3.2 RESEARCH DESIGN

This study followed the case study approach as described by Moore et al. (2023) and Yin (2015) to investigate how AI educators reached through the large AI Campus community use and integrate OER in their teaching and learning practices in relation to educational contexts. Moore et al. (2023) emphasised that 'the case study approach is particularly well-suited to illuminating "why" and "how" questions' (p. 2687). In this methodology, clear sampling and selection rationales and criteria are crucial. In this case study, we focused on German-speaking educators from the DACH region who are active users of the AI Campus, including both the usage of own AI Campus content as well as content from other platforms and initiatives providing OER on the topic of AI.

The sample included educators from all education sectors to (1) obtain an overview across all education sectors and (2) to enable the determination of any education sector-specific differences in the results. To reach out to this target population we combined the case study with survey research (Groves et al., 2011) using a quantitative online survey approach.

Before the online survey, we developed a first set of items and validated the questionnaire through external expert reviews with researchers from four different German higher education institutions. Using their feedback, we created the final questionnaire for the survey study.

3.3 DATA COLLECTION TOOLS

Regarding data collection, respondents were first contacted in October 2023 via the AI Campus main learning management system (LMS) mailing system, targeting 28,493 recipients. The

criteria specifically requested that only educators participate. Additionally, the survey was distributed via other channels and communities such as the AI Campus teaching fellowship programme.

Data collection was carried out through an online instrument hosted on LimeSurvey, ensuring both data protection and anonymity. The survey's introduction informed participants about the anonymous submission of their responses, making it impossible to trace responses back to individual identities, except in instances where respondents consciously disclosed personal information in response to the open questions. Participation was entirely voluntary, and a purposive sampling method was applied to deliberately select a diverse group of educators.

The questionnaire comprised nine closed-ended questions along with three open-ended questions related to demographic information and contact information. The survey consisted of five overarching categories, of which at least the first two categories had to be completed to be considered for inclusion in the study.

3.4 SAMPLING AND RESEARCH PROCEDURES

A total of 573 participants responded to the survey. Subsequent data cleaning and scrutiny resulted in a refined dataset of 260 participants, — 220 with fully completed questionnaires and 40 with partially completed responses. The data cleaning followed a documented seven-step process (see Figure 1).

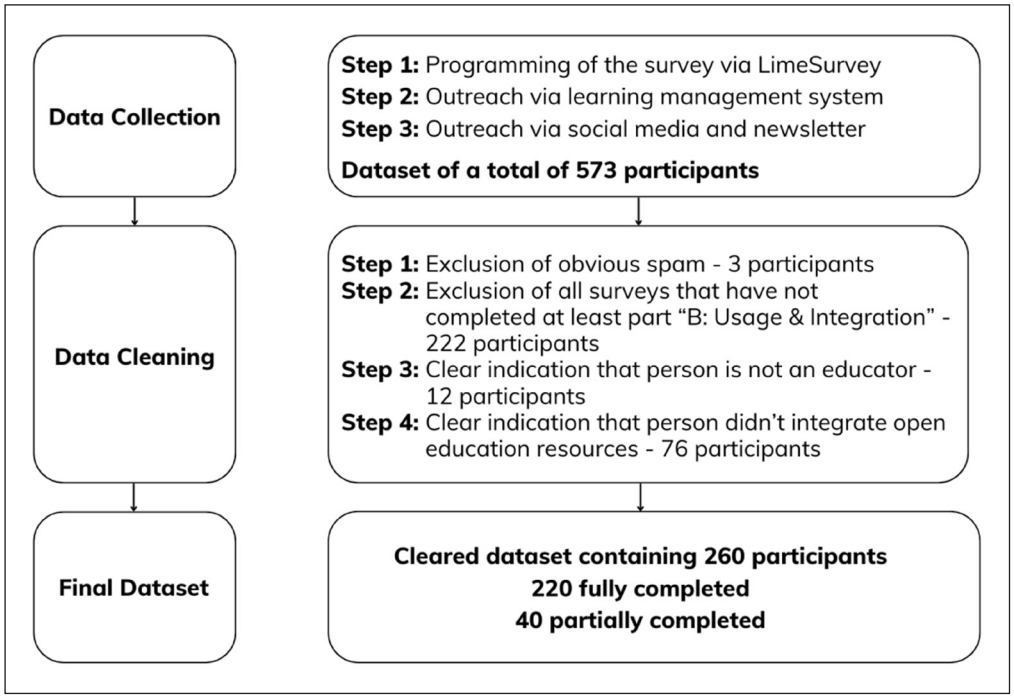

Figure 1 Data Collection and Cleaning (Own Illustration).

The data were analysed descriptively using Python. To assess the quality of the sample, a power analysis was conducted using G*Power. The findings affirmed that the sample exhibited a sufficiently high level of statistical power ($1-\beta = 1$, $\alpha = .05$), underscoring the robustness and reliability of the collected data. To analyse the descriptive results, we conducted chi-squared tests with the aim of finding significant differences between education sectors in relation to relevant items in the survey.

The 260 respondents were educators in different education sectors. The majority of respondents, comprising 52.3% ($n = 136$), reported being currently engaged in the higher education sector. Moreover, 30.4% ($n = 79$) indicated their involvement in professional learning and development (PL). This category consolidated responses from the survey related to 'non-formal education', 'vocational education' and 'continuing education'. Additionally, 11.3% ($n = 29$) reported being active in the primary or secondary school education/K–12 sector. Furthermore, 6.2% ($n = 16$) fell under the 'other' category, which includes educators who are active in several education sectors as well as people from companies that offer holiday school courses or voluntary initiatives (e.g. for refugees).

4 RESULTS

4.1 INTEGRATION OF OER

First, we highlight the results related to the integration of OER in AI education, such as digital formats used, the learning scenarios in which they are being used, how they are integrated and assessed and what the AI-related educational objective is. Table 1 presents the results in relation to each aspect. We analyse the results as a whole and describe the differences between the education sectors.

Table 1 Answers (in Percentages) on the Integration of OER per Education Sector (Multiple Answers Were Possible).

	TOTAL	*PER SECTOR*		
		SCHOOL *(n = 29)*	**HIGHER ED** *(n = 136)*	**PL** *(n = 79)*
Digital Formats				
Specific parts/modules	53.5	72.4	52.9	50.6
Entire courses	32.3	6.9	38.2	31.6
Videos	38.5	37.9	39.7	35.4
Podcasts	10.8	13.8	11.0	8.6
Exercises/simulations	26.5	37.9	20.6	27.8
Publications	13.1	6.9	11.8	15.2
Blog posts	12.7	13.8	14.0	10.1
Learning Scenario				
Online	57.7	24.1	57.4	70.9
Hybrid/blended	34.6	34.5	45.6	21.5
Face to face	38.1	79.3	33.1	30.4
Integration Form				
Supplementary without assessment	65.8	75.9	61.0	68.4
Supplementary with assessment	22.3	20.7	27.2	15.2
Recognition of a completed course through ECTS	10.4	10.3	10.3	11.4
Recognition of a completed course and other credits	6.9	6.9	8.1	7.6
Assessment				
Independent examination	23.5	42.9	18.3	26.3
Written examination (part of module)	12.0	10.7	14.5	7.9
Oral examination (part of module)	4.4	3.6	3.1	6.6
Project work	23.5	17.9	22.1	28.9
No assessment	44.2	28.6	47.3	43.4
Educational Objective				
Basic AI knowledge	86.6	92.9	83.5	89.3
Enabling the development of skills to act	53.3	64.3	50.4	50.7
Support the development of an attitude towards AI	54.9	75.0	50.4	57.3

4.2 DIGITAL FORMATS

One central question of the survey was which digital formats of OER educators use in their own educational work (multiple answers were possible). Overall, the majority of participants (53.5%) had already utilised specific parts or modules from courses. Meanwhile, 38.5% mentioned the incorporation of video formats and 32.3% reported integrating entire online courses. This demonstrates the educators' tendency to selectively curate content and incorporate relevant targeted materials, such as videos and specific course components, from the diverse offerings of the AI Campus rather than adopting entire courses outright.

When comparing different education sectors, we can observe differences regarding their integration and use of digital formats (see Figure 2). For example, 72.4% of school/K-12 educators indicated the use of specific course components, while only 6.9 % opted for complete courses. Those in K–12 education use comparably more application-related exercises or simulations than those in higher education.

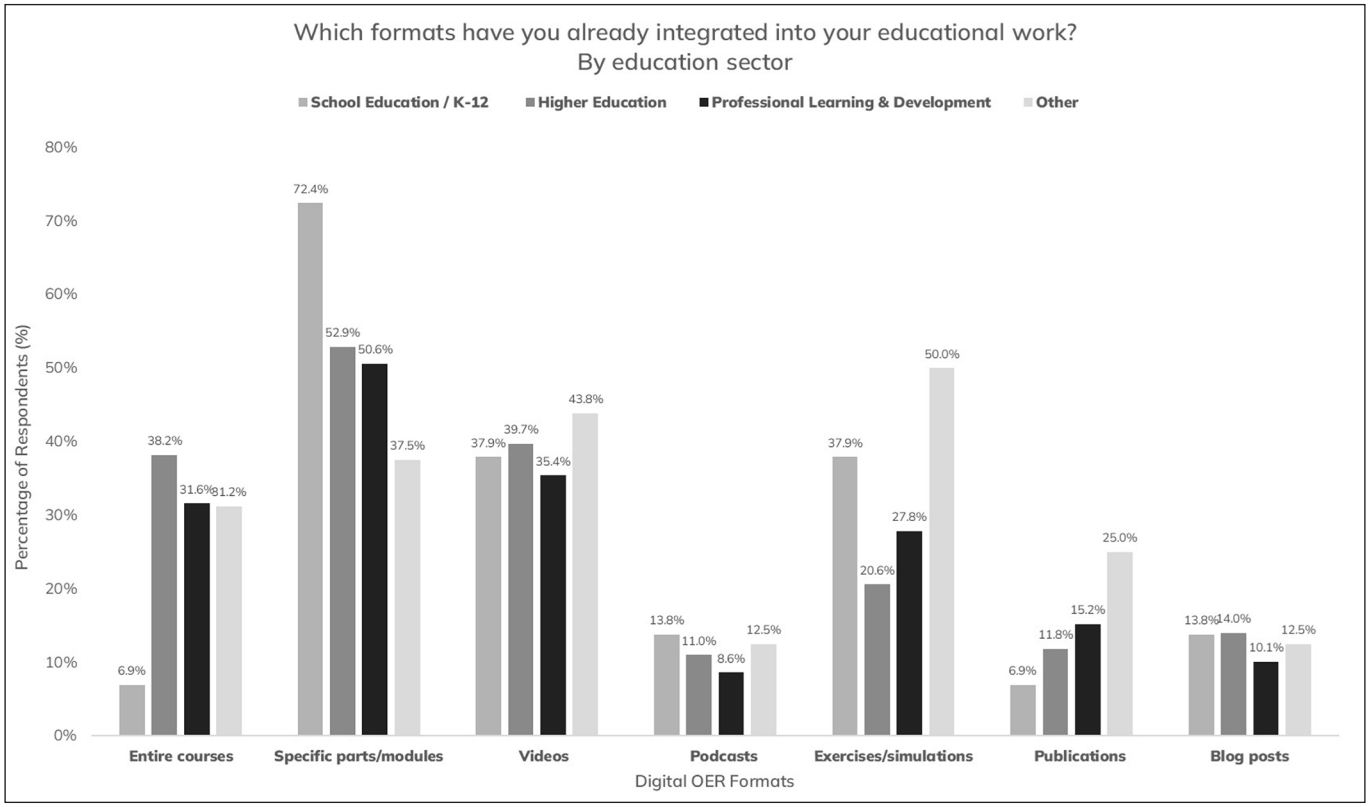

Figure 2 Integration of OER Formats per Education Sector.

Regarding professional education, half of the educators integrated modular formats, and a third incorporated exercises and simulations into their educational practices, highlighting the practical approach to the learning and development of hands-on skills. Regarding the adoption of entire online courses, the higher education sector led the field with 38.2% of higher education educators mentioning this. At the same time, over 50% of higher education educators indicated that they integrated parts of modules or modular offerings.

Overall, chi-squared test results indicated a statistically significant association between education sector and the integration of an entire online course ($\chi^2 = 10.77$, $p = 0.01$) and between education sector and the integration of exercises/simulations ($\chi^2 = 8.99$, $p = 0.03$).

4.3 LEARNING SCENARIOS

Aside from the digital formats of OER used, we also investigated the learning scenarios in which educators incorporated educational resources (see Figure 3). Overall, 57.7% of educators indicated utilising OER within a fully online setting. There was significant deviation in the use of online learning scenarios by education sector (Chi-square test results: $\chi^2 = 19.03$, $p = 0.00$). Online scenarios were popular among educators involved in professional learning and development and higher education sectors while only a very small proportion of educators from the school sector integrated OER into purely online scenarios.

Overall, 34.6% of the educators adopted a blended or hybrid format, combining digital formats with traditional face-to-face settings. Respondents from the higher education sector exhibited the highest adoption rate at 45.6%. Chi-squared test results indicated a statistically significant association between education sector and the blended learning scenario ($\chi^2 = 18.91$, $p = 0.00$).

Additionally, 38.1% of the educators reported integrating AI Campus content in face-to-face scenarios in the classroom. However, the most significant variance among the education sectors, was observed for face-to-face scenarios, being relevant to almost 80% of school educators.

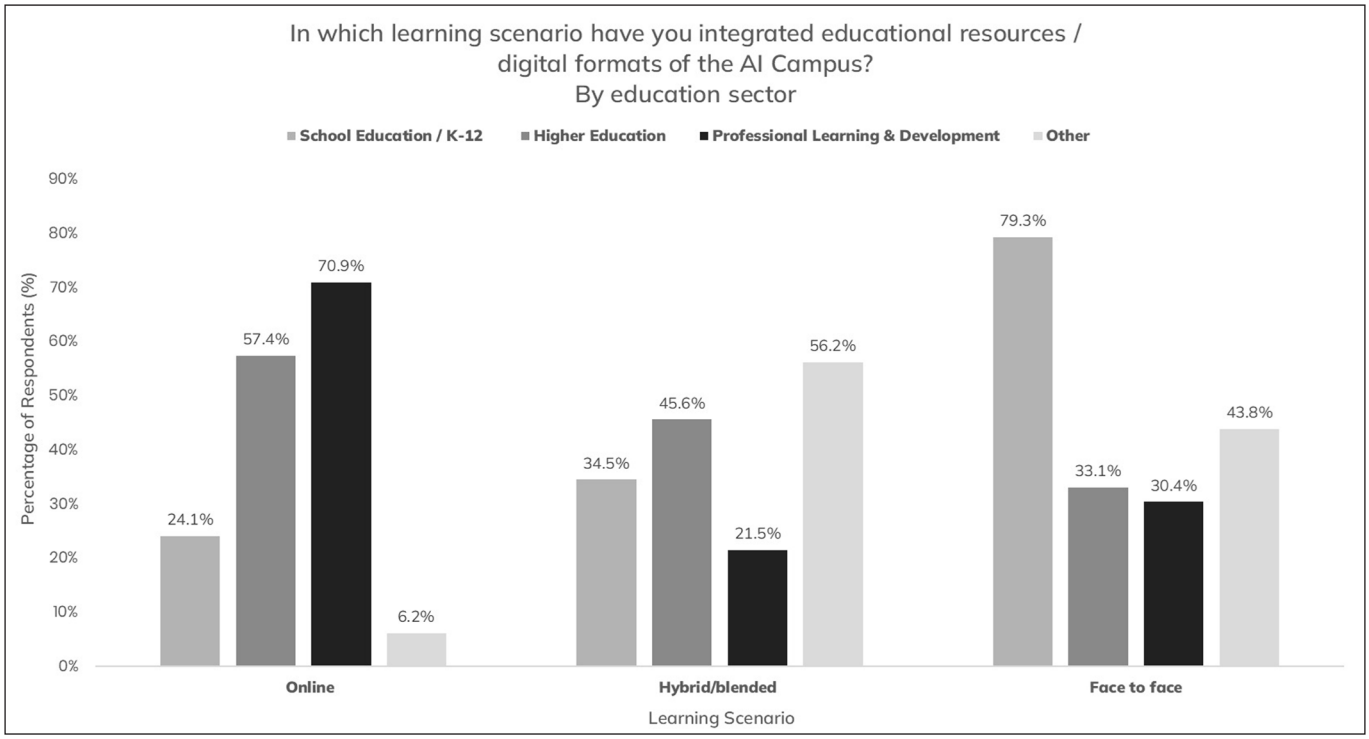

Figure 3 Use of Educational Resources in Different Learning Scenarios, per Education Sector (Multiple Answers Were Possible).

4.4 TYPE OF INTEGRATION AND ASSESSMENT

Regarding the type of integration, two-thirds (65.8%) of the respondents indicated that they utilised AI Campus resources as supplementary material, 22.3% reported an integration that goes hand in hand with an assessment of specific content and 10.4% used AI Campus content for recognition, such as awarding credits upon course completion. Here, minimal and not significant deviation among the educational areas was observed (see Table 1).

Regarding the assessment of learning success, approximately half of the respondents (44.2%) expressed that they do not assess the learning success of their students in this specific AI education context. Meanwhile, 23.5% evaluated learning success within project-based work and 23.5% employed individualised examinations. Less commonly chosen methods included written exams (12%) and oral exams (4.4%).

Comparing the education sectors, the school education sector exhibited the most significant deviation. Notably, the overall preference for not assessing learning success was less prominent in this sector, with only 28.6% of school educators adopting this approach. Conversely, school educators predominantly opted for assessments through individualised examinations (42.9%). A chi-squared test indicated a statistically significant association between education sector and individualised examination ($\chi^2 = 8.33$, $p = 0.04$).

4.5 AI LITERACY: EDUCATIONAL OBJECTIVES OF USING OER

Regarding educators' overarching educational objectives with respect to AI literacy, 86.6% aimed to provide basic knowledge of AI (Know what), 53.3% aimed to enable the development of AI skills (Know how), and 54.9% of educators targeted the development of an attitude (towards AI). An attitude is defined as 'a relatively enduring and general evaluation of an object, person, group, issue, or concept on a dimension ranging from negative to positive' (American Psychological Association, 2024). This is related to the concept of critical evaluation or the 'Know Why' (Bozkurt, 2024, p. 285) in the context of AI.

A notable deviation was observed in the school education (K–12) sector, where 75% of educators wanted to support the development of an attitude towards AI which is a significantly higher percentage compared to the other sectors (see Figure 4). However, the chi-squared test results narrowly indicated no statistically significant association between education sector and educational objectives ($\chi^2 = 10.77$, $p > 0.05$).

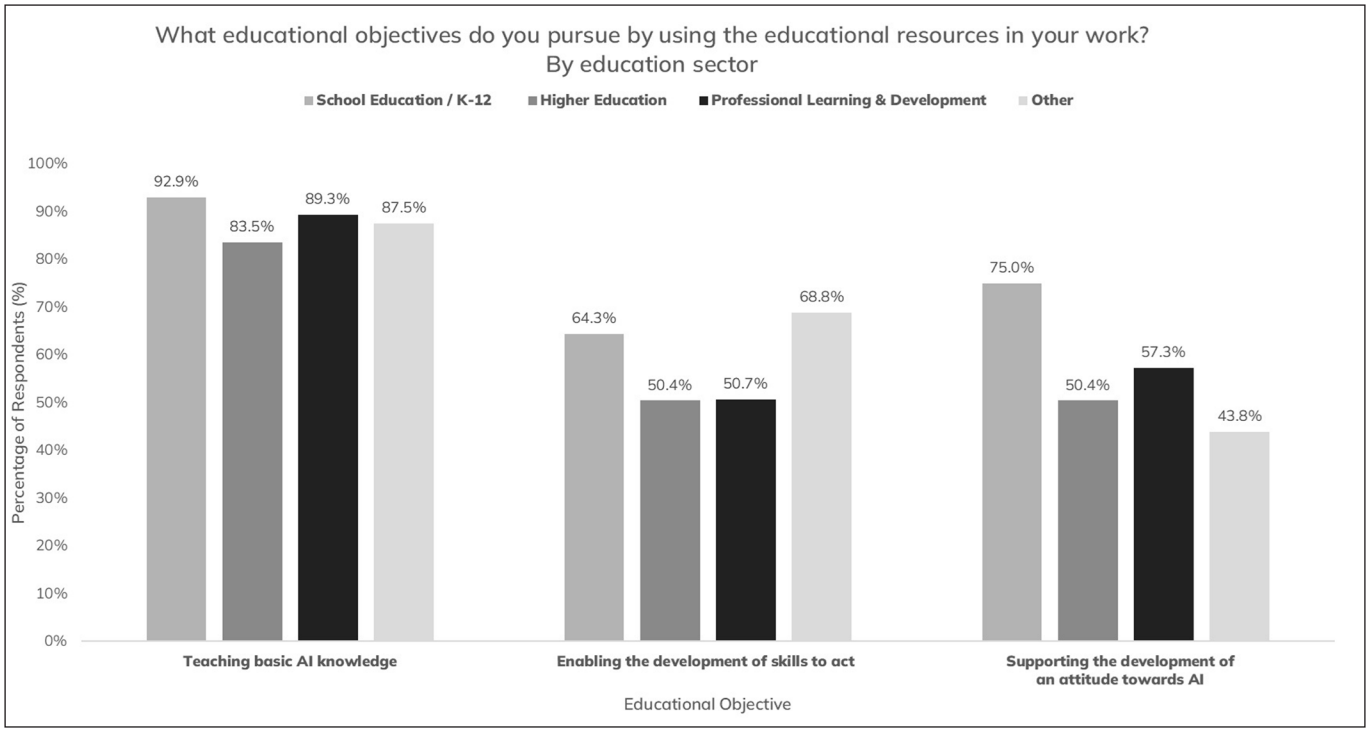

Figure 4 Educational Objectives.

4.6 REASONS FOR THE USE OF OER

This section focuses on the drivers informing the use of the AI Campus and its resources. Table 2 shows the overall results and by education sector. In exploring the reasons why educators chose to utilise the educational resources provided by the AI Campus, the survey results revealed that the most prominent factor is the availability of suitable content, with 81.1% of respondents highlighting this aspect (see Table 2). This underscores a strong alignment between the content offered by the AI Campus and the specific needs of educators. Subsequently, 63% of educators attributed their use of OER to the high quality of the material, indicating a perception of excellence in the content provided. Other significant factors include the appeal of no-cost availability (73.7%) and the presence of an open licence (55.1%), which underlines the importance of such OER principles. Conversely, factors such as the personal or institutional affiliations of the content creators wee less commonly cited as motivations.

When examining differences across education sectors, notable distinctions emerged, particularly in the importance placed on the OER aspects of the resources provided, such as free availability and open licences. These factors appeared more critical to educators in higher education (87.2%) and school education (78.6%) compared to educators in professional learning and development (66.7%). Additionally, the factor of high quality plays a substantial role for educators in Professional Learning and Development (66.7%), as well as in the higher education sector (63.7%). The experts who created the content seemed surprisingly unimportant; there was only a visible subgroup in the higher education sector (21%) for whom this was relevant.

Table 2 Reasons for using the OER Provided or Referred to by the AI Campus by Education Sector (Multiple Answers Were Possible).

	TOTAL	*PER SECTOR*		
		HIGHER ED *(n = 136)*	**SCHOOL** *(n = 29)*	**PL** *(n = 79)*
Reasons				
Appropriate content	81.1	81.5	82.1	82.7
Free availability	73.7	78.2	78.6	66.7
High quality	63.0	63.7	53.6	66.7
Open licence	55.1	60.5	60.7	46.7
Appropriate format	51.4	55.6	53.6	44.0
Provider (institution)	18.1	18.5	10.7	22.7
Provider (individual)	14.4	21.0	7.1	8.0

5 DISCUSSION

5.1 MAIN FINDINGS

The results show that across education sectors, course modules and smaller digital OER formats such as videos, exercises or course modules can play an important role in AI education. AI and OER have the potential to mutually benefit one another. Just as AI can enhance the implementation and accessibility of OER (Ossiannilsson et al., 2024), OER can serve as a valuable resource for advancing the use and understanding of AI. The educators' deliberate approach to the selection and adoption of materials tailored to their specific learning objectives and difficulty levels has already been described in the literature on the adoption of MOOCs in the classroom (de Jong et al., 2020). Diverse learners seem to benefit from a variety of smaller formats for their foundational education in AI. The opportunity for educators to receive these free of charge and flexibly from a learning platform seems particularly promising. The significance of high-quality materials is underscored by findings from other recent studies that align closely with our results (Klar et al., 2024). With the help of OER, AI educators are able to teach AI regardless of their institutional environment or available time and financial resources, fulfilling a core promise of openness in education.

In this landscape, open learning platforms like the AI Campus with its versatile offerings and OER infrastructure at scale can serve as a driver enabling open practices (Hiebl et al., 2023), strengthening cooperation, bridging gaps in the education system and supporting educational offerings across institutions and sectors. To achieve this, it seems important to reflect on the different usage options and integration pathways regarding digital OER formats and suitable learning scenarios. For example, this could mean offering OER for the school sector in a way that they add value for teachers addressing their students in a face-to-face classroom.

Another noteworthy finding is that OER are predominantly utilised as supplementary materials, often without associated assessments. One possible reason is that digital or blended scenarios with larger groups offer fewer opportunities for examination, and digital formats are used more as additional materials, in the context of project or portfolio work or supporting discussions in class.

Regarding AI-related educational objectives, educators prioritise assisting their learners in gaining foundational knowledge or an understanding of AI. Basic AI literacy for all appears to be the major objective across sectors. This is followed by developing the skills to act and by approaches to support the development of balanced attitudes towards AI coming last. These findings correspond with the priorities Almatrafi et al. (2024) identified in a systematic review of recent AI literacy implementation efforts across sectors. Although the findings are barely statistically significant, the differences by sector appear interesting regarding the higher importance of addressing AI attitudes in the school sector.

The findings on how educators use digital OER formats for AI education are in line with the need for the modularisation of learning materials (Egloffstein & Ifenthaler, 2023). Educators can support learning success if they have flexible materials at their disposal. This means, for example, that learning platforms focused on larger online courses such as MOOCs need to develop even more adaptive and stackable approaches if they want to be integrated into formal and non-formal education across sectors.

Regarding the drivers and motives of AI educators in using OER, content is king: The three major reasons educators reported were the availability of suitable content, free or no-cost availability and the high quality of the content provided. The content creator or individual providing OER plays only a very minor role, and the same applies to the institution: For educators, reputation seems to be surprisingly unimportant. An interesting open question remains: How important is reputation to learners when it comes to obtaining a formal certificate after using an educational resource such as an online course? The question also remains as to the extent teachers reflect on the use of OER or their open educational practice in general and as to whether the particular concept of OER adoption (Klar et al., 2024) for an average educator is less important than the principles associated with it.

Overall, the case study provides initial insights into differences between the education sectors. Some results, however, were not statistically significant. In terms of the digital OER format chosen, we were able to identify statistically significant differences between the sectors

with regard to the formats of full online courses and exercises/simulations. AI educators in higher education and professional education were much more likely to use an entire online course. Furthermore, suggesting an entire online course as OER material to educators in the school sector appears not very promising. However, they showed a particular preference for application-orientated exercises or simulations. The use of online scenarios was favoured in the areas of professional education and training and higher education, while only a very small proportion of AI educators from the school sector integrated OER into purely online scenarios. This is consistent with the results on the use of entire online courses.

Blended or hybrid scenarios were particularly important in higher education when it comes to the use of OER. The results were particularly clear with regard to the use of OER in combination with pure face-to-face scenarios. This was only done by a clear majority of educators in the school sector; in the other sectors, this combination was significantly less common. This shows how the potential of OER can be fulfilled in the context of AI if one clearly considers such different scenarios and the typical needs of educators in different sectors.

5.2 IMPLICATIONS FOR RESEARCH AND PRACTICE

Our study investigated how AI educators use OER in their teaching. Educators and their learners face similar issues: As mostly non-experts, they have to deal with rapid technological developments and the growing importance of (generative) AI in the classroom. Leveraging the potential of open education can be instrumental in scaling AI literacy for everyone. A first step towards this is a better understanding of suitable educational resources to support AI education in general and in a sector-specific manner. Small digital formats like videos, exercises or course modules are more important than full courses to support AI educators. This information has consequences for content development and OEP that intend to have impact in different education sectors. At the same time, more cross-sectoral research on OER adoption is needed, and the topic of AI could be a driver of this.

In this context, our study demonstrated the need for more investigations around OER for AI education. Future work could focus on investigating the effectiveness of different formats in different educational contexts combining both cross-sectoral principles and sector-specific particularities. There is also great potential in further research into the modularisation and adaptation of OER and open online courses, as well as the role of AI systems and tools for (OER) content creation.

5.3 LIMITATIONS

This study has some limitations that should be considered. First, the investigated case of the AI Campus community targeted the German speaking DACH region. The results therefore highlight the regional context of open learning approaches (Ruipérez-Valiente et al., 2022) and are not necessarily generalisable to all regions. This corresponds to a challenge facing educational research in general.

Second, the representativeness of the survey sample is limited, as only a small fraction of educators could be targeted and respondents were already early adopters in using digital formats and OER in their AI education. In particular, non-expert educators who show 'negative attitudes towards AI' and might have a 'weak self-efficacy' in the context of AI (Chiu et al., 2023, p. 12) were most probably not amongst the population of educators included in this survey. Another limitation is the self-reporting of educators in this case study. The extent of their OEP could have been overestimated in some cases.

6 CONCLUSION

AI as a topic has taken on unprecedented momentum in all sectors of education. Many teachers in schools, universities, further education and other sectors have bravely taken on the task of acting as multipliers to provide their learners with the appropriate education on AI. Some educators also use resources and open online courses from digital learning platforms. This case study showed how diverse the approaches and needs of teachers and possible usage scenarios are. The results further implied that the discussion should focus more on smaller digital OER formats and the modularity of courses and content, especially from the perspective

of the needs of educators. From their perspective, suitable content and free availability are crucial. In the context of MOOCs, the use of an entire course is not the norm, except for the higher education sector, but the use of a suitable part of an online course can be very helpful to support AI educators across sectors.

In general, this paper broadens the perspective on how AI education or AI literacy programs can be implemented from a cross-sectorial perspective, with a focus on the potentials of digital education and the adoption of OER in the AI classroom. The results also showed that suitable and high-quality content such as online courses and other digital formats can be used well to achieve the goal of AI literacy for all.

To really achieve broad AI literacy and AI adoption in the classroom across sectors with the help of OER and OEP, those who experience strong uncertainties in the context of AI must be encouraged developing an open and balanced perspective on technology and to close their own knowledge and skills gaps.

At the core of this case study, the RQs and findings intended to identify low-threshold suggestions for using OER to enhance (uncertain) educators' work. Suitable content as the core motivation of potential AI educators using OER in the classroom is emphasised here. The great uncertainty on the subject of AI can be a catalyst for stronger and more differentiated use of OER than before.

Some findings also indicated that there are sector-related differences both in learning scenarios and in the motivation to use such materials in AI teaching. The study also confirmed that the modularisation of OER in general, but also online courses in particulars is central to their integration into teaching across all sectors.

Finally, the case study identified a need for further research, as several questions remain unanswered: How can AI educators in each sector be best supported as multipliers with the help of OER? How can education about AI support OER adoption across sectors? What kind of AI literacy do educators themselves need, especially as non-experts? How can AI support the development and adaptation of OER? These questions need to be researched through larger systematic surveys and reviews, as well as qualitative surveys to make the individual perspectives of educators visible.

SUSTAINABLE DEVELOPMENT GOALS (SDGs)

This study is linked to the following SDG: Quality education (SDG 4), Decent work and economic growth (SDG 8).

DATA ACCESSIBILITY STATEMENT

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

ETHICS AND CONSENT

Informed consent was obtained for the survey described in this article. All collected data were anonymised and participants participated voluntarily. All procedures were performed in compliance with relevant data protection regulations and institutional guidelines.

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS (CRediT)

Florian Rampelt: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Writing – Review & Editing; Raffael Ruppert: Methodology, Investigation, Software, Formal Analysis, Visualization; Johannes Schleiss: Conceptualization, Methodology, Writing – Review & Editing; Dana-Kristin Mah: Conceptualization, Writing – Review & Editing; Katharina Bata: Conceptualization; Writing – Review & Editing; Marc Egloffstein: Conceptualization, Writing – Review & Editing. All authors have read and agreed to the published version of the manuscript.

AUTHOR NOTES

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AUTHOR AFFILIATIONS

Florian Rampelt orcid.org/0000-0003-3604-813X
Stifterverband für die Deutsche Wissenschaft e.V., Germany

Raffael Ruppert orcid.org/0009-0001-2921-012X
Stifterverband für die Deutsche Wissenschaft e.V., Germany

Johannes Schleiss orcid.org/0009-0006-3967-0492
Otto von Guericke University Magdeburg, Germany

Dana-Kristin Mah orcid.org/0009-0004-2106-2216
Leuphana University Lüneburg, Germany

Katharina Bata orcid.org/0009-0009-5968-4260
Karlsruhe Institute of Technology, Germany

Marc Egloffstein orcid.org/0000-0002-2377-7889
University of Mannheim, Germany

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