

Exploring the Digital Divide in Workplace Learning: A Rapid Review

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Abstract— This article examines the digital divide in workplace learning, with an emphasis on the disparity in the distribution of Advanced Learning Technologies (ALT) across different types of workplaces. The study employs a rapid literature review methodology to analyze the utilization of ALT in workplace learning. The findings indicate that the use of ALT is predominantly concentrated in the education, health and medical sectors, with limited implementation in other sectors. Moreover, in smaller organizations, in non-technical sectors and among white-collar workers, there are fewer opportunities for technology-enhanced learning. The study highlights the need for more inclusive and comprehensive research to address the digital divide in workplace learning, taking into consideration practice-based evidence and exploring the themes covered by training. Furthermore, the paper proposes an investigation into the complexity and resource intensity of implementing ALT to enhance technology-based learning in all workplaces. In general, this research establishes the basis for comprehending and bridging the digital learning divide in the workplace.

Keywords-advanced learning technologies; technology-enhanced learning; digital divide; workplace learning.

I. INTRODUCTION

A large share of lifelong learning occurs during and alongside work and often has a rather informal character [1] [2]. In this context, much is foreseen from Advanced Learning Technologies (ALT). ALT are characterized by careful instructional design, a high degree of interactivity and a holistic approach to the assessment of learning outcomes [3]. Some examples for ALT are adaptive learning systems, mobile micro-learning, augmented or virtual reality applications and even digitally supported types of collaborative ("social") learning. When designed well, these technologies can make self-regulated learning-on-the-go at the workplace easier, allowing individuals to take control of their learning and regulate it according to their needs [4]-[6].

A particular concern, however, is that access to technology-enhanced learning opportunities is not the same for all workers, which systematically deprives those employed at workplaces with little ALT-enhanced learning opportunities from nurturing their employability and fostering their individual professional development and growth. The scope of our research is to gain insights in the relative distribution of opportunities to benefit from ALT for re- and upskilling in the workplace, i.e., the digital divide in workplace learning.

A deeper understanding of the digital divide in workplace learning could be a step towards more equitable access to ALT, which facilitates personal and professional growth,

employability, and thus the advancement of social justice and inclusion. In conclusion, addressing this divide not only enhances organizational competitiveness but also provides new perspectives for comprehensive and inclusive workforce development policies.

The paper is structured as follows. Section II describes the State-of-the-Art. Section III presents the methodological design of the literature review, followed by the description and interpretation of results in Section IV. Section V concludes with some future directions of research.

II. STATE-OF-THE-ART

In the past, inequalities in access and use of Information Technology (IT) have been discussed against the backdrop of the concept of the "digital divide", i.e., "digital inequalities between individuals, households, businesses or geographic areas" that arise from disparities in physical access to IT infrastructures, digital competency of users but also in unequal capabilities, engagement, and use outcomes [7]. So far, the digital divide has been, for example, discussed at the individual (i.e., age, income, educational level, digital competencies, language barriers) level and the regional level (country, remote areas vs. rural areas) [8]. During the COVID-19 pandemic, we have experienced firsthand that the digital divide can severely limit access to education for those who are digitally left behind [9]-[12], leading to reduced education equity [13]. To our knowledge however, there is no systematic analysis yet that sheds light on the digital divide in *workplace* learning, i.e., processes related to learning and training activities at various levels of an organization, thus *at work* [14][15].

For this paper, and drawing on the general definition of the digital divide provided by [7], we define the digital divide in workplace learning by the variations in the utilization and adoption of adult learning practices across different types of workplaces. More concretely, we hypothesize that whether one works in a small or a large company, whether one works in the public or the private sector, and what job field (e.g., blue vs. white collar) one is working in severely affects one's opportunities for technology-enhanced learning. From a workplace ethics and sustainable development perspective, access to opportunities for re- and upskilling From the perspective of workplace ethics and sustainable development, access to lifelong learning opportunities should not depend on job characteristics, but should be inclusive and equitable, as required by the United Nations Sustainable Development Goals [16]. Furthermore, barriers in the access to ALT at the workplace create disparities for individual workers and puts

the up- and reskilling of our workforce at risk, which is urgently needed for future employability.

Earlier studies show that the use of ALT is heavily skewed towards the educational sector [17][18], as well as towards academic professions, in particular health and medical care (ibid.) and information technology [19][20]. To give an example, in the review study by Granić [17], about 80 percent of the studies covered came from the educational field. Similarly, in the review by Yu et al. on information technology in workplace learning [20], 18 out of the 60 studies analyzed were from the medical field. There is also some evidence that ALT is less used in public services (3 out of 60 studies in the review of Yu et al. [20]) than in business enterprises [20][21] – 3 as compared to 34 in the review by Yu et al. [20] – and that smaller and medium-sized enterprises lag behind in the adoption of ALT [22].

However, even if the studies mentioned above provide informative starting points, we argue that a reliable and more granular picture of the digital divide in workplace learning is missing: Most studies rely primarily on evidence predating 2020, before the digitization boost caused by the COVID-19 pandemic. Therefore, they can be considered somewhat outdated. Two of the three studies covering very recent evidence do not [18] or not fully [22] qualify as *systematic* reviews. Recent systematic reviews cover rather specific topics such as instructional planning in e-learning [23] or the effect of technology-enhanced learning and training on organizational-level learning outcomes [19], or they focus on specific occupations and sectors, in particular those such health professionals [24] or teachers [25] where the use of ALT is frequent. The most recent systematic review by Yu et al. [20] found that only 19 out of the 60 studies analyzed (ibid, p. 4912) focused on individual employee learning processes within enterprises. The remaining studies investigate the interplay of meta-constructs, such as technology acceptance of ALT in general or satisfaction with online forms of learning at the workplace rather than focusing on individual-level workplace learning processes. However, the review does not provide a detailed analysis of institutional characteristics or delve deeply into ALT.s The current literature highlights how little we know about the varied utilization of ALT across industries, occupations, and diverse institutional settings (e.g., large vs. small, public vs. private).

To address the described gap in the literature, we propose an alternative approach to analyzing the literature on technology-enhanced workplace learning. We advocate for a shift towards examining *specific examples* of technology-enhanced workplace learning *implementations* aimed at *individual* learning processes within *distinct workplace contexts* to obtain a more nuanced understanding of the disparities in technology-enhanced workplace learning depending on the type of workplace. This approach allows us to shed light on the research question how access to digital learning opportunities is affected by the type of institution and the professional field.

III. RESEARCH DESIGN

We conducted a rapid review [26] to evaluate the digital divide in workplace learning. Rapid reviews, which fall within

the framework of Cochrane review methods [27, p. 5], are a streamlined approach to gathering evidence through synthesis and have a shorter turnaround time compared to traditional systematic reviews. The following section explains the search and selection strategy that we derived from the objectives of this study – to describe the digital divide in workplace learning. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses [28][29] (PRISMA) approach was adopted to guide the screening process (see also Figure 1).

The search strategy was as follows: We identified peer-reviewed journal publications published in the English language, and focused on technology-enhanced learning at the workplace. We used the Web of Science (WoS) online database to search for relevant publications, as this database matched best our search strategy and promised an efficient identification of relevant publications (contains peer-reviewed journal publications). Only publications published in 2020 or later were included. This is because we assume that the implementation of ALT in the workplace has undergone structural changes as a result of the COVID-19 pandemic. Review articles were excluded, as we are interested in institutional-level implementations of technology-enhanced learning.

TABLE 1: CONSTRUCTION OF THE SEARCH STRING

Explanation	Components of the WoS search string		
<i>online learning or synonymous term in title referring to the use of ALT</i>	(((TI= ("digital" OR "virtual" OR "online" OR "hybrid" OR "remote" OR "blended" OR "distance" OR "web-based") AND TI=("learning*" OR "training*" OR "course*")) OR TI=("e-learning" OR "elearning" OR "e-training" OR "entraining" OR "microlearning" OR "micro-learning" OR "mobile learning" OR "mobile-learning" OR "learning app"))		
	AND		
<i>concrete implementations...</i>	(AB=("case stud*" OR "company case*" OR "field stud*" OR "field experiment*" OR "questionnaire*" OR "survey*") OR TI=("case stud*" OR "company case*" OR "field stud*" OR "field experiment*" OR "questionnaire*" OR "survey*"))		
	AND		
<i>... at the workplace</i>	(AB=("workplace*" OR "business*" OR "industry*" OR "industries*" OR "enterprise*" OR "compan*" OR "public service*" OR "public sector*" OR "civil serv*" OR "corporat*" OR "professional*" OR "SME*" OR "governm*" OR "continuing education") OR TI=("employee*" OR "worker*"))		
<i>exclude ALT applications aimed at students or pupils as well as machine learning applications</i>	NOT AB=("student" OR "students" OR "pupil*" OR "machine learning" OR "deep learning" OR "reinforcement learning") NOT TI=("student" OR "students" OR "pupil*" OR "machine learning" OR "deep learning" OR "reinforcement learning")		
	AND	AND	NOT
<i>relate to one of the three fields</i>	education	health and medical field	other fields
	AND	AND	NOT
	(TI=(teacher* OR faculty* OR lecturer*) OR AB=(teacher* OR faculty* OR lecturer*))	(AB=("health*" OR "care" OR "medic*" OR "surg*" OR "radiol*" OR "dementia*" OR "clinic*" OR "nurse*") OR TI=("health*" OR "care" OR "medic*" OR "surg*" OR "radiol*" OR "dementia*" OR "clinic*" OR "nurse*"))	TI=(teacher* OR faculty* OR lecturer*) NOT AB=(teacher* OR faculty* OR lecturer*)) NOT AB=("health*" OR "care" OR "medic*" OR "surg*" OR "radiol*" OR "dementia*" OR "clinic*" OR "nurse*") NOT TI=("health*" OR "care" OR "medic*" OR "surg*" OR "radiol*" OR "dementia*" OR "clinic*" OR "nurse*"))

Our search string (see also Table 1) refers to different synonyms of e-learning, and made reference to real-life ALT applications in a workplace setting. The search terms underwent further refinement and revised by an information specialist at the Brandenburg University of Applied Sciences. The final search string included restrictions (e.g., students at higher education institutions, pupils at schools, machine-learning applications) for settings that do not classify as workplace learning.

Searches were conducted from February 16, 2024, to February 26, 2024, and yielded a total of 561 records (no duplicates). To account for the skewed distribution of publications on ALT towards the educational and health sectors, we conducted three separate searches for technology-enhanced learning (ibid.). These searches were conducted for educational institutions (N=130; 23% of records), for the health and medical sector (N=238; 42%) and for all other fields (N=193; 35%).

We recognize that this first step is merely an approximation, as we had not yet screened out records based on titles, keywords, and abstracts that may not be related to the use of ALT at the workplace. However, considering the high frequency of articles related to education and health and medical fields, and recognizing that most institutions in these fields are likely to be large and public sector-based, we believe that this approximation falls within the efficiency required by the chosen methodology (rapid reviews) while still retaining substantial validity for assessing the digital divide in workplace learning.

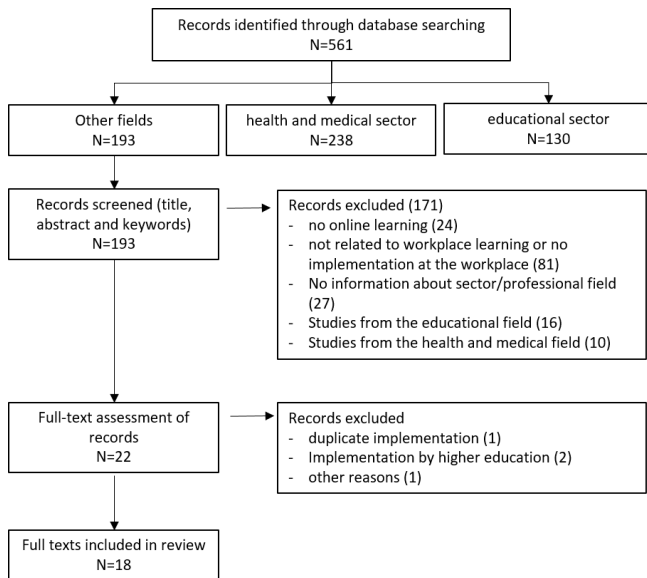


Figure 1. PRISMA chart

TABLE 2: DISTRIBUTION OF ALT-USE AT THE WORKPLACE

Study	Institution	Sector	Profession	ALT	COLL
[30]	N/A	retail	diverse	MicroL	no
[31]	large	public	diverse	MobileL	yes
[32]	several	engineering	engineers	other	yes
[33]	large	business services	white-collar	other	yes
[34]	large	automotive	blue-collar	VR	no
[35]	large	public	white-collar	MicroL	no
[36]	several	IT	IT specialists	MicroL	no
[37]	large	public	both	other	no
[38]	medium	industrial services	blue-collar	VR	yes
[39]	N/A	food	N/A	other	no
[13]	large	energy	blue-collar	VR	no
[40]	N/A	energy	blue-collar	VR	no
[41]	large	steel	blue-collar	VR	no
[42]	several	electronics	blue-collar	VR	no
[43]	several	education	other	other	no
[44]	several	public	blue-collar	VR	yes
[45]	several	agriculture	blue-collar	MobileL	yes
[46]	large	chemical	diverse	other	N/A

Notes: ALT = advanced learning technologies, COL = collaborative learning, MicroL = micro-learning, MobileL = mobile learning, VR = Immersive virtual reality training

The screening strategy for the 193 records resulting from the search for other sectors was as follows: Titles, keywords, and abstracts were screened for each record. Records that did not mention 'online' in connection with 'learning' (N=24), were not related to workplace learning or did not contain detailed information about a specific implementation at the workplace (N=81), excluding, e.g., studies focusing on organizational learning processes rather than individual learners' competency building, and studies that discuss abstract concepts or the interplay of general constructs in technology-enhanced workplace learning. Furthermore, we excluded studies without information about sector or professional field (N=27). This meant, e.g., that we exclude cross-sectional studies covering a large number of different institutions.

Furthermore, we identified additional review studies that have not been excluded in the initial WoS search routine (N=3). Similarly, we excluded further studies that refer to education (N=16) or to the health and medical field (N=10) that still ended up in the search results for "other sectors".

The remaining N=22 publications were included in full text screening. We excluded two additional studies because they were implemented and/or tested in a higher education context. Another was focused on knowledge management with MS Office and social media tools rather than with technology-enhanced learning. Moreover, we found two studies using the same ALT implementation example that we treated as duplicates and excluded one of them.

The 18 final full-text records underwent detailed analysis to gain systematic evidence on the digital divide in workplace learning. The screening was conducted with respect to the characteristics of the institution and the workplace, such as size, sector, and type of job.

IV. RESULTS

Initially, the scarcity of studies on advanced learning technologies for workplace learning beyond higher education and healthcare is noteworthy. This scarcity suggests that – at

least evidence-based and scientifically evaluated – implementation of ALT in the workplace is not yet that widespread, as we would expect given the generally acknowledged importance of reaping the benefits of ALT for workplace learning. Full-text screening of the 17 relevant studies identified yields the following picture (see also Table 2): The great majority of examples of ALT use at the workplace refers to large organizations or to cross-institutional implementations with participants from several institutions (e.g., engineers or agricultural workers employed in different companies or being self-employed). Our sample only contains one example at a medium-sized enterprise, and none at a small organization. Moreover, most applications are from technical sectors, such as energy, engineering, or automotive rather than from the service sector. Immersive virtual reality training (single or multi-player) is the most frequently found ALT, followed by mobile and micro-learning implementations. The picture becomes even clearer when we look at the occupational fields targeted by ALT in the records studied: it is mainly blue-collar workers who have access to ALT, especially VR-based immersive training.

A third of the records analyzed cover ALT that fosters networked learning, i.e., collaboration between learners. Here, we cannot find differences in the use of ALT between white-collar and blue-collar professions.

V. DISCUSSION AND CONCLUSION

The present study examines the digital divide in workplace learning, which refers to the varying degree of use of ALT in different workplaces. By conducting a rapid literature review, we confirm existing evidence suggesting that the use of ALT is heavily skewed towards occupations in the education, health and medical sectors. It is not surprising that there is a skewness or disparity in these fields, as the institutions are typically large and resourceful organizations with a certain proximity to research-oriented practices, which may be more willing to embrace innovation and technological advances, as well as learning and training.

Further screening of the literature has revealed that there is a lack of ALT implementation at the workplace in other sectors, at least in terms of implementations that have been scientifically evaluated and the results have been published in peer-reviewed journal articles. Our results show that technology-enhanced learning opportunities are less frequent in smaller organizations, non-technical sectors (including the public sector) and for white-collar workers.

A major limitation of our research is publication bias. We may assume that the likelihood of writing an academic publication and publishing it in a peer-reviewed journal is higher in academic fields, such as health and education, which may partly explain the great number of results on the use of ALT for workplace learning we found.

Still despite these methodological limitations, our results indicate that there seems to be a digital divide in workplace learning, in particular along employer size and technological sector. Given that for example in Europe, almost two thirds of the employed workforce is working in small or medium-sized enterprises [47], and similarly, almost three quarters are employed in the service sector [48, p. 48], this poses a threat

to workforce up- and reskilling and may severely hamper learning opportunities and individual development and growth for employees at such workplaces.

Further research focusing on the digital divide in workplace learning may broaden the perspective and take into account more practitioner-based evidence on ALT use at the workplace. This could be achieved by including a more inclusive database, such as Google Scholar, which also indexes conference proceedings, preprints or institutional repositories, in its search routine.

In addition to this methodological extension, it would also be interesting to determine the themes covered by the training, in order to get an even more detailed picture of the digital divide in workplace learning at the level of work tasks and duties, rather than just at the level of workplaces and institutions.

It is also an open question to what extent the digitalization and the shift to remote work, accelerated by the COVID19 pandemic, affects the digital divide in workplace learning: On the one hand, ALTs have increasingly been introduced to train workers remotely [49]. On the other hand, many people have lost their jobs during the pandemic, or have had their working hours reduced, or have been working from home in isolation, depriving them of workplace learning opportunities. It remains to be seen what long-term impact this will have on ALT-based learning opportunities for different groups.

Finally, we suggest more closely investigating the technologies used to implement ALT at the workplace, in particular concerning the complexity and resource intensity of implementation, as this might be a reason why smaller institutions use ALT less frequently to boost workplace learning. This could lead us to discover that digitally-enhanced learning functions as a Socio-Technical Information System (STIS) [50]. As our paper emphasizes, ALT systems may currently be sub-optimally designed, as many of them were originally developed for or by large private companies, or tailored to educational institutions, overlooking the diverse reality of institutions that lack experience in ALT provision and would rather need lightweight approaches for implementation.

In summary, our paper sets the stage for an in-depth exploration of workplace disparities in accessing ALT, laying the foundation for understanding the digital learning divide. By acknowledging the socio-technical nature of ALT and its current suboptimal design, we pave the way for future discussions on optimizing technology-enhanced learning for all workplaces, regardless of size, sector, or individual characteristics.

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