# Developing Employees' Digital Competence with Informal Learning in the Work Process[1]

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ABSTRACT

With the rise of information and communication technologies (ICT) in workplaces, employees require adequate digital competence. This paper addresses the question of how employees can acquire and further develop the digital competence required to perform their work tasks. Conventional training methods face challenges such as rapid technological development, high costs, and difficulties in transferring knowledge, which impede the continuous development of digital competence. Studies indicate that regular ICT use at work supports digital competence development. Given the benefits of workplace-based learning in ICT task performance for developing digital competence, the design of work to facilitate learning is an important prerequisite. The main contribution of this paper is to highlight the relevance of informal learning in the work process for the development of employees' digital competence. Further research should explore the role of work design in facilitating digital competence development at work.

**Keywords**

Digital competence – information and communication technologies – informal learning – work design

## 1 Introduction

The use of information and communication technologies (ICT) in the workplace is increasing. An acceleration of digitalisation processes following the implementation of work-from-home measures in response to the Covid-19 pandemic, as well as the fast-paced development of new ICT, has been noticed (López Peláez et al., 2021). ICT is defined as an umbrella term encompassing digital devices (e.g., computers) and digital tools (e.g., emails and video conference tools) that facilitate the creation, sharing, and storage of digital information (Schauffel et al., 2021; Vuorikari et al., 2022). A survey of German employees in various industries revealed that, on average, eleven different ICTs are used at least weekly (Gimpel et al., 2018). Furthermore, employees require ICT to fulfil their work tasks. Consequently, they must possess adequate competence in handling ICT at work.

Competencies are generally understood as complex characteristics, including systems of generalised mental processes, which enable individuals to execute appropriate actions in any situation (Hacker & Sachse, 2023). Based on expertise research, individuals who are assumed to have higher competence levels (i.e. experts) are able to transfer their knowledge to new tasks and problems. It is not solely the knowledge (know-about) but knowledge connected to action (know-how) in the form of principles and heuristic procedures that enable competent individuals to solve problems and detect errors. Experts' knowledge is more activity-relevant and holistically organised than non-experts' knowledge, who are assumed to have lower competence levels (Hacker, 1992). Competence is generally understood to develop through learning and practice rather than internal dispositions (Gruber, 1994).

Competence in the context of work, also referred to as vocational action competence (Sonntag & Schäfer-Rauser, 1993) includes knowledge, skills, abilities, and experiences that enable individuals to be capable of action in familiar and new work situations. Widely acknowledged is the differentiation in professional-, social, methodological, and personal or self-competence (Bergmann, 1999). Methodological competence includes procedures or strategies that can be used across all sectors, such as problem solving (Berg-

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mann, 1999). Kauffeld (2021) added and classified the competence of handling ICT as a subdimension of methodological competence. More commonly, this is referred to as 'digital competence' (Müller et al., 2023).

The European Parliament and the Council (2006) have identified digital competence as one of eight key competencies for lifelong learning, which is relevant for various jobs and employees. Digital competence is a requirement for employability and enhanced career prospects in an environment where job content and context are undergoing rapid digitalisation (Krebs & Maier, 2022).

Furthermore, research has identified correlations between digital competence, health, and motivation. Studies have demonstrated that individuals with high levels of digital competence report increased employee well-being (Golz et al., 2021; Mungra et al., 2023), increased engagement and motivation (Chan et al., 2021; Mungra et al., 2023), and increased job performance (Ochoa Pacheco & Coello-Montecel, 2023).

Considering the positive effects of digital competence, it is essential to understand how it can be acquired and developed. Most research on acquiring and developing digital competence has been conducted with students in the educational context. In the professional context, teachers' digital competence has been mainly studied. Few studies exist in other professional areas (Murawski & Bick, 2017).

Formal training is often part of an organization's approach to employee skill development. However, due to several limitations of the training, digital competence needs to be developed continuously while interacting with ICT. This can be achieved through informal learning at work while using ICT. The use of ICT in the workplace demands a continuous learning process from employees to maintain and update knowledge and skills to keep up with new ICT developments (Day et al., 2012).

This paper aims to answer the following research question: How can informal learning in the work process support the development of digital competence?

To address this question, we will first define and operationalize digital competence (Section 2). Next, we will explore the roles of ICT training and informal learning in the workplace to foster digital competence development (Sections 3 and 4). Finally, we will provide recommendations for designing work environments that support and enhance the effectiveness of informal learning (Section 5).

The main contribution of this paper is to highlight the importance of informal learning in the work process for the development of employees' digital competence.

## 2 Defining digital competence

Digital competence at work is defined as „a set of basic knowledge, skills, abilities and other characteristics that enable people at work to efficiently and accomplish their job tasks regarding digital media at work" (Oberländer et al., 2020, p.5). The term digital media is understood to be equivalent to ICT. The most cited reference model of digital competence is the 'Digital Competence Framework for Citizens' (DigComp) (Ferrari, 2012; Vuorikari et al., 2022), developed by the European Union. The model describes 21 competencies, which are organised into five areas. The five areas are as follows: (1) information and data literacy, (2) communication and collaboration, (3) digital content creation, (4) safety and (5) problem-solving. An individual's level of digital competence can be assessed on one of eight proficiency levels using descriptors and behavioural examples.

In the workplace context, digital competence is primarily evaluated through self-report measures such as questionnaires. Questionnaires typically include the five dimensions of the DigComp framework such as ICT self-concept (Schauffel et al., 2021). In contrast, objective assessments such as knowledge or performance tests are costly and challenging to implement (Mattar et al., 2022; Peiffer et al., 2020). Therefore, the literature mainly focuses on self-reported digital competence, also understood as competence beliefs (Mattar et al., 2022). Competence beliefs such as ICT self-concept are argued to be reciprocally related to objective digital competence. However, it should be noted that discrepancies cannot be ruled out due to individuals' over- or underestimation (Peiffer et al., 2020).

## 3 Challenges of ICT training in developing digital competence

It is widely acknowledged that competencies such as digital competence can be acquired and developed through learning (Weinert, 2001). Organisations may invest in formal learning opportunities to develop employees' digital competencies. Formal learning is a systematically planned and structured process with pre defined learning objectives, methods, and timing. It is supported by a facilitator and recognised through diplomas or certifications (Manuti et al., 2015; Watkins & Marsick, 1992; Wolfson et al., 2018). For instance, sponsored software training outside an employee's workplace ('off the job') is considered formal, intentional, and other-directed (Wolfson et al., 2018).
However, there are several limitations to digital competence training.

*Firstly*, while training is typically entangled and thus very beneficial to the introduction of novel ICT (Spitler, 2005), it also takes place in advance occasionally. Hence, individuals must remember the knowledge and skills conveyed until the time they need them (Havelka & Rajkumar, 2019). The timely implementation of training is challenging due to the fast pace of developments in ICT. As ICT evolves constantly and rapidly, some changes may not be reflected within the training due to time restrictions or simply because they are not sufficiently apparent. In addition, the frequency of training would need to increase with each new development in ICT (Baethge-Kinsky, 2020). This aspect of quickly outdated knowledge has been called the „half-life of knowledge". IT knowledge has been stated to have a half-life and become outdated after 1.5 years (BIBB, 2013). On the contrary, Möller (2017) argues that IT knowledge, for example, about old computer systems, is still valid but becomes less useful or applicable over time. This is supported by Helmich and Leppelmeier (2020), who stating that there is no empirical basis for half-lives of knowledge and knowledge does not lose its importance. Instead, it is a clarification, actualisation, and expansion, expanding the knowledge to be more precise and actual (Helmich & Leppelmeier, 2020). This suggests that ICT-related skills and knowledge need to be continuously updated and expanded.

*Secondly*, training is costly. Smaller organisations may find it challenging to cover temporarily absent employees who participate in external training, which would lead to a competitive disadvantage (Hacker, 2015). Especially in times of demographic change and staff shortage, this may be challenging. This may lead to ICT training not being offered and accessible to every employee. A survey of German employees of various industries revealed that 72 % of the employers offered training for digital technology (DGB, 2022). However, the availability of training does not mean that employees actually participate. Studies report that only 20 % (Nüßlein & Schmidt, 2020) to 43 % (Tijdens & Steijn, 2005) of surveyed employees attended formal ICT training in their organisation. Additionally, Wicht et al. (2021) assume that particularly older employees receive less formal training in digital competence.

*Thirdly*, the effectiveness of training depends on the content, more precisely, what area of digital competence is targeted in the training (Hinojo-Lucena et al., 2019). For example, studies on ICT training at work have found that the training significantly predicted certain areas of digital competence, such as communication and problem-solving (Van Laar et al., 2019) or information and data literacy, security and problem-solving (Hinojo-Lucena et al., 2019). However, the authors did not specify the content of the training. Peiffer et al. (2020) argue that there is a lack of training to promote holistic digital competence in all areas. Baethge-Kinsky (2020) argues that ICT training is often limited to visible functions and superficial knowledge about operating and handling ICT. Therefore, ICT training may focus a single ICT but does not include the diversity of ICTs an employee uses and cover all possible scenarios (Blume et al., 2010).

*Lastly*, the knowledge-gain of training depends on the transfer into the employees' workplace. Transfer refers to the process by which learning effects from a practised task are applied to modified, new tasks (Bergmann, 1999). This transfer is dependent on various characteristics of the trainee (e.g. motivation, perceived usefulness, previous experience, post-training knowledge), the training design (e.g. training method, voluntary participation, trainer characteristics) and the work environment (e.g., support) (Arthur et al., 2003; Blume et al., 2010; Grossmann & Salas, 2011; Havelka & Rajkumar, 2019; Tzafilkou et al., 2021). The learned knowledge in training must be transferred to a completely different context. Various ICTs may be used with different interfaces, or the ICT infrastructure or data policy may restrict certain actions specific actions that were learned. Regarding the training method, it has been argued that adults are less interested and receptive to instructional learning formats outside of work (Ng & Feldmann, 2012). Behavioural modelling is considered to be a more effective training method for ICT learning than classroom instructions (Davis & Yi, 2004; Havelka & Rajkumar, 2019). For example, Gist et al. (1989) found that those university managers who saw video material of a person describing how to use computer software and then imitated it (behavioural modelling) achieved higher mastery of computer software than a group who received only visual on a screen.

The evidence for ICT training in fostering digital competence is inconclusive. Some studies suggest that teachers who attended ICT training reported feeling significantly more digitally competent than those who did not (Baytar et al., 2023; Kahveci, 2020; Krumsvik et al., 2016). However, the effect was reported to be small when performance-based digital competence was measured after ICT in-service training with Finnish teachers (Saikkonen & Kaarakainen, 2021). In contrast, others could not detect significant effects of ICT training variables on self-perceived digital competence (Rodríguez-Moreno et al., 2021).

Considering the issues of (1) timing, (2) costs and availability, (3) training content and (4) transfer difficulties into account, it appears that ICT training is not sufficient alone to develop digital competence, must be accompanied by continuous learning is necessary. Thus, continuous, ongoing informal learning at work, while interacting with ICT, can complement ICT training.

## 4 Advantages of informal learning while using ICT at work

In a meta-analysis, Cerasoli et al. (2018) define informal learning as „non-curricular behaviours and activities pursued in service of knowledge and skill acquisition that occur outside formally designated learning contexts. Such activities are predominantly self-directed, intentional, and field-based. Informal learning behaviours are not syllabus based, discrete, or linear." (Cerasoli et al., 2018, p. 204). Informal learning is related to ICT use. ICT use at work is defined as the „individual user's employment of one or more features of a system to perform a task" at work (Burton-Jones & Straub, 2006, p. 231).

*Firstly*, an advantage of informal learning compared to ICT training is that it is not tied to a specific time point but happens continuously. Employees spend much of their work time executing tasks with ICT (DGB, 2022). Through these tasks, they encounter various situations where they acquire new action-regulating knowledge and skills (Hacker & Sachse, 2023). If employees encounter a problem with using ICT, they need to find solutions to continue their work and complete their tasks (Korpelainen & Kira, 2010). The more frequently employees utilise ICT, the greater the probability they will engage in such situations, adapt to new changes, and gain new knowledge and skills in real time (Ilomäki & Rantanen, 2007). Proficiency development, such as digital competence, is argued to be reinforced through frequent interaction with ICT and repetition of its use (Reder et al., 2020; Wicht et al., 2021). Saikkonen and Kaarakainen (2021) found that digital activity, defined as the use of ICT, was a stronger predictor of teachers' digital information skills than receiving in-service training in digital topics.

*Secondly*, informal learning incurs no additional costs compared to ICT training.. This makes learning accessible to more employees. Indeed, qualitative studies have indicated that digital competence is more often acquired through informal learning behaviours when using ICT to solve work problems or collaborate with others (Lemmetty & Collin, 2020). Approximately 70 % of surveyed Dutch employees in a study by Tijdens and Steijn (2005) indicated they had taught themselves how to handle ICT. This is confirmed by findings from Korpelainen and Kira (2010) who found that 79 % stated learning to use ICT informally. Informal learning strategies included trial and error, seeking help from written material, and asking others or trying out with others (Korpelainen & Kira, 2010).

*Thirdly*, as informal learning is embedded in the work context, real and practical problems are given and learned. Expertise research suggests, that individuals with higher competence are generally assumed to have more detailed and differentiated mental models as their knowledge is better organised, such as connected to action steps, allowing it to be retrieved an applied as needed (Bergmann, 1999; Hacker, 1992). By interacting with ICT in daily work tasks, employees may encounter several problems that need to be solved, for example, through trial and error (Youssef et al., 2015) or producing digital content (Ilomäki & Rantanen, 2007). Lemmetty and Collin (2020) report through qualitative interviews that learning about ICT occurs naturally during everyday work, as problems arise when using ICT that require resolution. The content is precisely what employees need to accomplish their work tasks. As there are diverse demands, diverse corresponding areas of digital competence can be acquired or developed.

*Lastly*, transfer is simplified as action patterns and examples are trained in an authentic work context in which they are later applied. Skills are best developed when repeated under constant conditions at work. Additionally, employees may train in multiple contexts and tasks, which helps to decontextualise the knowledge, making it easier is helpful to retrieve it for novel situations and problems (Bergmann, 1999). However, the extent of learning depends on the design of the work tasks, which should be learning-conducive (Brater & Rudolf, 2006). The most helpful training method for ICT training, behavioural modelling, be easily impletented in the work context. Employees can observe colleagues using ICT and receive feedback and information when executing and imitating newly learned ICT functions.

The research on ICT use in fostering digital competence at work has used several different operationalisations of ICT use. Some studies have focused on the dichotomy of use versus non-use. As expected, students who use computers and tablets report higher levels of self-perceived digital competence than those who do not (Barboutidis & Stiakakis, 2023).

Further approaches have conceptualised use through more nuanced frequency indicators of use such as rating scales (e.g. never to daily) or time spent using ICT (e.g. two hours daily) (Almerich et al., 2021; Burton-Jones & Straub, 2006; Trice & Treacy, 1988). Many studies have employed this for a specific use, such as using computers. For example, Schauffel et al. (2021) applied the ICT-SC scale to a sample of German employees ($N$ = 571). They measured the frequency of everyday use of various ICTs taken from the Programme for the International Assessment of Adult Competencies (PIACC, Rammstedt, 2013). The scale enquired about the frequency of use of the following: email, internet, payment services, spreadsheet programs, online conferences/chats, and test processing. Respondents were asked to indicate the frequency of use in everyday life on a scale from never to daily. The results indicated that higher everyday ICT use was as-

sociated with higher ICT-SC, as shown by significant positive correlations ($r$ = .19 to .40) (Schauffel et al., 2021).

Another conceptualisation of ICT use incorporates the diversity of use, which can be achieved by combining various ICTs into an overall indicator of ICT use. This approach considers that the use of different ICTs with different functions, picturing the multidimensionality of ICT use (Rice & Leonardi, 2013; Trice & Treacy, 1988). For example, Schulze and colleagues (2021) found that German university students who reported using various ICTs weekly had higher self-perceived digital competence based on DigComp than those who used ITCs less than weekly.

It should be noted that most of the mentioned studies focused on ICT use in everyday life without differentiating between work-related and personal ICT use. The personal use of ICT outside of work has been argued to be more intensive than ICT use at work (Corrin et al., 2010). Studies have demonstrated that personal ICT use in student samples is associated with higher self-rated overall digital competence (Almerich et al., 2021; Díaz-García et al., 2023; Rubach & Lazarides, 2019). Additionally, in employee samples, everyday personal ICT use was related to specific subareas such as digital security (Dodel & Mesch, 2018) or digital problem-solving (Wicht et al., 2021).

However, it can be argued that personal ICT use does not necessarily equate to ICT use at work, as it lacks a variety of purposes and tasks that can only be found at work (Schulze Heuling et al., 2021).

Work-related use refers to the frequency individuals utilise various forms of ICT for work-related tasks. The research on the association between work-related ICT use and digital competence is limited. For instance, Tijdens and Steijn (2005) found that the intensity of ICT use (percentage of weekly work time spent with ICT) significantly predicted higher proficiency levels in handling ICT in a sample of Dutch employees. Results from Oberländer and Bipp (2022) support this as the percentage of daily work time spent with ICT was moderately correlated with digital communication and collaboration competence. Furthermore, Norwegian teachers who reported working 10-12 hours per day with laptops reported the highest self-perceived digital competence, whereas those who reported working 0-2 hours reported the lowest self-perceived digital competence (Krumsvik et al., 2016). These findings assume that work-related ICT use can be assumed to be a predictor of digital competence, independent of personal ICT use.

## 5 Learning-conducive work design to enable informal learning with ICT

The question arises of how organisations can design workplaces that promote digital competence development using ICT. Studies have examined the positive effect of learning-conducive work design on the development of professional competence (Bergmann & Pietrzyk, 2000; Friebe, 2005; Richter et al., 2018; Richter et al., 2020). To achieve this, it is crucial to implement employee learning and work design that is human-centered and learning-conducive, facilitating learning at work. The learning potential of a workplace describes the objective learning demands and the fact that there are learning opportunities and a learning culture that also foster learning motivation (Hacker & Sachse, 2023).

In a systematic review, Wielenga-Meijer et al. (2010) introduced a heuristic model depicting the relationship between task characteristics, learning processes, and learning outcomes. The heuristic framework combined various theories such as the job characteristics model (Hackman & Oldham, 1975), Job demand-control model (Karasek, 1979), action regulation theory (Hacker, 1986), and others. This heuristic framework proposes that an employee's knowledge structure can be shaped by an accumulation of work-related learning processes resulting from work design characteristics. Work design characteristics such as job demands, variety, autonomy, and feedback affect various cognitive, metacognitive, motivational and behavioural learning processes, which result in learning outcomes. Digital competence can be understood as a learning outcome. Parker (2017) extended the heuristic model as the Work Design Growth Model (WDGM), which elaborates on the underlying learning processes and adds more work design characteristics (Schaper, 2021). The action-regulation theory is one possible explanation for the underlying processes (Hacker, 1986). It posits that individuals actively learn through goal-oriented regulation of knowledge and actions. Learning occurs in sequential phases involving orientation, goal setting, execution, control, and reflection. For example, when individuals encounter ICT problems, this is regarded as a discrepancy between the actual state and a target goal state. This discrepancy initiates and motivates to take action to solve the gap. Procedural knowledge is created throughout the process by executing the actions and receiving advice and feedback from others (Hacker, 1986, 2003).

Recommendations on which work design characteristics are relevant can be found in regulations for well-designed work tasks such as the DIN EN ISO 6385 (2016) (DIN, 2016) or the standard VDI/VDE-MT 7100 (VDI/VDE, 2024).

## 6 Conclusion

To prepare employees for the digitalisation of the workplace and enable them to utilise the potential of ICT, they must acquire the necessary digital competence. ICT training may be a starting point, but continuous learning can be provided through informal learning with ICT at work.

Further research in the project 'PerspektiveArbeit Lausitz' [PerspectiveWork Lutsia] (https://pal-lausitz.de) (PAL), funded by the Federal Ministry of Education and Research, will investigate the anticipated positive effects of work design on the relationship between ICT use at work and ICT-SC. The PAL project aspires to establish a competence centre in the federal states of Saxony and Brandenburg for the future of work with technologies and ICT. The regions are undergoing three significant changes due to (1) the brown coal phase-out, (2) the high proportion of the older population in terms of demographic change and (3) the digitalisation processes within organisations. The digitalisation and the availability of employees with high digital competence are perceived as valuable assets in addressing the challenges currently facing the regions. Digital competence is essential even when demands at work are changing. Being digitally competent may enable employees to stay employable and work in different industries as it is a transversal competence. A well-designed and age-appropriate work design is required to ensure employees' employability and the organisation's competitiveness (Baltes et al., 2019).

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