# The systematic integration of technology enhanced learning for lifelong competence development in a corporate context

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**Abstract.** Digitization causes fundamental shifts in economy and society. These changes will go in line with significant changes of corporate core competencies as well as the skills and capabilities of employees. Due to the increasing pace of technological development in production and service processes as well as the ongoing trend to automation classic educational approaches will no longer suffice to ensure the achievement potential as well as employability of people. Thus the need for workplace learning becomes more and more evident. One central opportunity arising with digitization is the implementation of workplace learning in form of technology enhanced learning. Consequently, this paper gives an overview of the nowadays relevant learning enhancing technologies. In addition to this, it suggests a roadmap to integrate technology enhanced learning into the corporate context as well as the existing competence development.

**Keywords:** digitization· work based learning · learning enhancing work design · vocational training · work design · technology-enhanced learning

## 1 Introduction

The increasing digitization is going to change labor and the roles of humans in industrial production significantly. Physical and monotonous activities and even certain planning and controlling tasks will be performed by computers and machines in the future. People, however, will mainly be responsible for strategic, coordinative and creative tasks as these are the kind of mental tasks machines cannot take over – yet. [1; 2]. These general observations can be underlined with the findings of FREY & OSBORNE from 2013. They analyzed the impact of digitization on the current job profiles in the US labor market and calculated the probability of jobs being replaced by robots or machines. They projected that about 40 % of the current job profiles will disappear in the next twenty years [3]. The study has been adapted by numerous international scientists and applied to the job market of different other countries in the last two years [4; 5]. Based on the work of the American researchers, German scientists calculated that, approx. 59% of current positions in Germany are in danger, too [5]. When analyzing these somehow alarming results, however, it should be noted that these studies do not take into account that at the same time a multitude of new job profiles will develop and possibly equilibrate the expected losses in employment. Consequently, other studies project fundamental gains in productivity and employment due to the digitization of service and production industries [6]. In addition to that, the changes which are to be expected are not an entirely new development - the vanishing and arising of job profiles has a long history in economic development. Up to now the relation between automation and unemployment has not been proven empirically but there seems to be an effect of technological change on frictional unemployment [7; 8]. This could be partially explained by the need and necessary time for requalification of formerly employed people. These findings are emphasized by research about the half-life of professional knowledge, which is broadly found diminishing [9-11].
While results like this need to be backed up by further research in the future, what seems to be clear at the moment is that the increasing speed of technological change, extensively discussed by authors like BRYNJOLFSSON & MCAFEE [12], will severely affect companies' qualification and competence demands as well as education and vocational training. Thus, not only educational institutions need to adapt their offerings but also companies need to ensure opportunities for lifelong learning and to place a higher emphasis on the organizational learning processes. In addition to that the broader availability of technology enhanced learning does constitute a challenge in itself, since applicability and effects of these relatively new learning forms need to be evaluated.

These changes in education due to the availability of technology enhanced learning are also reflected in the rise of learning theories as so-called situated learning [13] or connectivism [11]. To what extent these learning theories are better suited to explain and implement technology enhanced learning needs to be evaluated thoroughly. Nevertheless, it is obvious at the moment that these learning theories could constitute a preliminary foundation for the paradigm shift of educational institutions and companies concerning the technology enhanced learning for the faster and faster ongoing digitization of society and economy.

## 2 Core competencies for a digitized world

The idea of corporate core competencies initiated by PRAHALAD & HAMEL [14] and further developed by TEECE ET AL. [15] under the notion of dynamic capabilities is essential in explaining the success of companies. But what are the main corporate core competencies that will contribute to the success of employees and companies in a digitized world?

### 2.1 Core competencies of companies

Considering the aforementioned changes in society and economy it becomes obvious that these core competencies are more and more about innovation capability and flexibility. Taking into account that nowadays four out of the ten of the companies with the greatest market capitalization did not exist 40 years ago and two of them are not even 20 years old, there seems to be a fundamental change which can be observed in the economy. In addition to that companies like WhatsApp (subsequently bought by Facebook for about 19 billion US$), Uber, myTaxi and AirBnB did alter and frame the business models in their industries significantly. So what does make these newcomers different from the existing companies in their industries? They even did not invent totally new business ideas but they were able to add value to the customer by combining existing industries and offering a platform based service by outsourcing tasks to their customers. But why were the existing players in the different fields not able to defend their markets?
The main reasons behind this were a higher innovation capability and organizational flexibility of these newcomers [16; 17]. These two qualifications will be important cornerstones for companies in implementing a competitive strategy in a digitized world. Whereas innovation encompasses the development and implementation of ideas, processes and products or services, which are considered as new [18; 19], organizational flexibility addresses the ability of an organization to answer continuously changes in their industry and environment [20; 21]. It has been proven that these relatively broad concepts are able to explain the enduring success of companies and the failure of others - at least partially. However, the gap in relation to organizational learning still persists. Though NONAKA & TAKEUCHI [22] ascribed organizational learning a pivotal role in innovation capability, CROSSAN ET AL. developed a framework for the implementation [23] the research on the success of organizational learning remains still open to interpretation. First reliable studies in this field so far have been undertaken by LORENZ & VALEYRE [24], CALANTONE ET AL. [25] and ALEGRE & CHIVA [26] which point in the direction that learning and especially organizational learning could contribute to innovation capability. But still, the question remains in how far we could train students and employees to foster these core competencies or to convince companies of the need to develop their human resource purposefully in this direction. And even if these development goals are translated into a company strategy it still needs to be decided how they can be translated into an employee development plan.

### 2.2 Core competencies of employees

The aforementioned shifts in the core competencies of companies also can be observed on a micro level considering the key qualifications of employees. The employees' competencies which will be needed to achieve the vision of smart factories as described in the German notion Industrie 4.0 include overview knowledge, digital literacy, skills for interdisciplinary communication and self-organization. But the main

important competence of future employees will be the capability and willingness to lifelong learning. Without it, Industrie 4.0 cannot succeed.
The changes caused by digitization call for innovative solutions in job design, human resources development and corporate governance, as well as the selection and the implementation of suitable technologies. The ongoing automation and digitization of many routine processes could create new opportunities to make better use of human capabilities like creative thinking, deciding and designing. Furthermore, companies´ collaboration will increase significantly and demand new management and leadership approaches, also affecting the degree of participation and involvement of employees. Corporate competitive advantages can only be accomplished, if the corresponding innovation capabilities and thus the ability to learn exist in companies. A number of recent publications and studies confirm this, they consistently emphasize the role of learning for overcoming the new challenges due to the increasing complexity of production. A German study found that about 80% of the companies surveyed had an additional qualification need due to the rising demands for flexibility and another 60% saw the need for a systematic skill development [27]. All in all, the development of the necessary skills and capabilities becomes a central challenge.
Therefore, vocational learning processes must be supported more than ever and new concepts for on-the-job training need to be developed [27]. One of the most promising concepts is the so-called workplace learning. It directly combines everyday work with continuous learning. This means that work systems and environments are designed from the beginning on in a learning enhancing way [28].

# 3 Competence development in a digitized world

The digitization of industries and society will also affect the way of learning since a multitude of learning technologies is nowadays available. However, companies still only implement these technologies very slowly. This is due to the lack of future job profiles, inconclusive implementation guidelines, lack of didactic principles and unclear suitability of different learning technologies [29; 30].

## 3.1 The need for workplace learning

The need to combine learning processes and everyday work tasks is not only based on the changing work environment and the proceeding automation in many different areas, it is also necessary because already established classic forms of learning would not be anymore sufficient to counteract the shifts in the demand of competencies [31]. Estimations for the half-life of knowledge once acquired by education or vocational training show that this knowledge lasts for around ten years, which means it decreased by 50% within the last twenty years [10; 32]. If learning is included into the daily everyday tasks, this loss of knowledge can be prevented. This is crucial, because the employees knowledge is one of the most important assets of a company as well as its one of its keys to success: On a macroeconomic level companies are more and more under pressure to continuously innovate and to be more flexible in order to defend their competitive edge, something which is only possible if their members of staff possess the latest expert knowledge. Digitization offers manifold opportunities to integrate learning into existing work processes. Digital media in form of technology enhanced learning systems can provide totally new opportunities of knowledge dissemination and lifelong learning in companies. For example, internal knowledge exchange and collaboration supported by social software can greatly contribute to employees' task performance and innovativeness [33].
Workplace learning provides the opportunity to endow employees with the necessary competencies to manage the complexity of the arising digital work and production systems. Simultaneously technology enhanced learning concepts can be integrated with management and controlling software and thus deliver a much higher benefit to workplace learning. The integration of learning and working into a sound concept of workplace learning demands the solution of numerous challenges:
It will be important to foster employees' self-organization and capability to make use of the available technologies, to teach the new work tasks and situations as well as to ensure the needed personalization and user friendliness in technology enhanced human resource development [34]. Furthermore, new interactive and

individualized learning forms need to be developed, which combine different forms of individual and organizational learning and are adapted to the cognitive capabilities of their target groups. In addition to that, the design of future work and production systems must not only be learning enhancing but also provide more flexible work organization allowing for higher degree of social permeability [35].

### 3.2 Technology enhanced learning

Since the mid-eighties a multitude of technology enhanced learning forms have arisen. The different development phases are shown in the following figure 1.

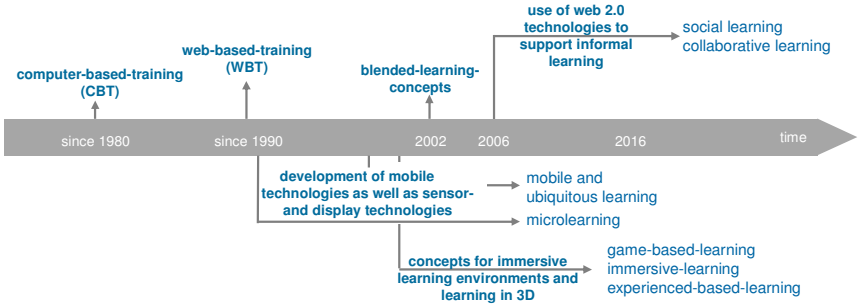


Fig.1. Development of technology enhanced learning (adapted from [36])

The first available technology enhanced learning form was *computer based training* (CBT). Though strongly limited by visualization and calculation speed, many companies experimented with this early learning form. However, CBT was mostly a virtual representation of available textbooks at that time. Nowadays CBT consists to a large part of self-contained, methodically and didactically edited learning units combining text, audio and video files with animations or simulations and it is stored on external devices such as CDs or DVDs [37; 38]. Another learning based technology that does not need any of these storage devices is the so-called *web based training* (WBT). It is internet-based and relies on the online saving of information. By doing so, WBT many times offers more information than traditional CBT because it is not limited to a specific amount of savable data. It also offers communication, interaction and collaboration opportunities as well as the chance to create collective content [39]. Another form of technology based learning is *blended learning*. As its name suggests, it is a combination of different learning techniques and blends traditional classroom training with CBT/WBT concepts. It is, so far, the most prevalent of the three technologies. [40; 41].

The rise of the web 2.0 in the past has caused fundamental developments in learning technologies. Because users can now actively participate in the learning process, they can make use of direct feedback loops and comment on the training they receive. More importantly, they can create joint knowledge and combine what they know with options like company wikis, chats or blogs. In addition to that, new graphical user interfaces (GUIs) make the creation, modification and collaborative development of content easier and further strengthen group trainings based online. Consequently, more and more companies use social software like wikis, weblogs, chats, forums and learning-communities to foster formal and informal learning processes. Because of this, sourcing and filtering solutions for shared knowledge become more and more important, considering the fast rising amount of digital available information. *Social learning* is a web-based learning form that makes use of social media platforms such as the before mentioned wikis or blogs. It stands for informal, self-organized and network-based processes [42]. *Collaborative learning* however is a form of social learning that emphasizes the competence development of groups, the knowledge exchange between its members as well as the joint knowledge generation. Thus, learners are responsible for actively creating, organizing and distributing knowledge [43]. Another influence to the changing learning theories is the development of modern mobile phones and devices. It has led to mobile and *ubiquitous learning* approaches because information can now be created, stored and shared anytime, anywhere [44]. The importance and disruptive nature of these new learning forms become evident given that with connectivism an even new learning theory has been developed [11].

Connectivism does not consider only the knowledge a person possesses but also the knowledge which is reachable within the person's network.
Despite all of these progresses in the area of technology based learning it remains somewhat unclear which of the different techniques is best used for what kind of task/challenge. To change this, an in-depth analysis of the individual companies' internal and external environment is necessary and will help to find the best suitable learning method for each case. How this analysis could look like and how the learning method is implemented best once it has been chosen is demonstrated in the following chapter.

## 4 The integration process of corporate technology enhanced learning

Once a company has decided to integrate technology enhanced learning into its daily tasks, this decision has to be followed by a carefully planned integration process. This paper suggests specific implementation steps for the roll-out of learning concepts.

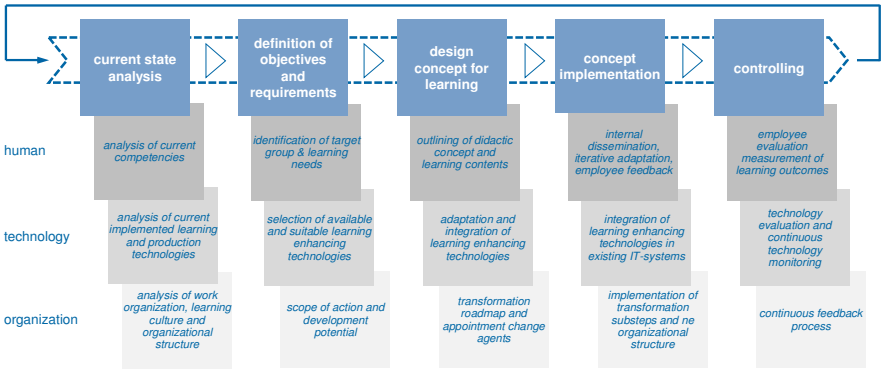


Fig.2. The integration process of corporate technology enhanced learning

One of the most important factor success factors is to establish a project team for the integration of technology enhanced learning solutions consisting of different departments like management, human resource, IT, industrial engineering as well as work council. The addition of work council and employee representation is the only way sufficient participation can be generated. The failure of many corporate knowledge management projects since the beginning of 2000 can be at least partially attributed to insufficient employee participation in its introduction process.

As shown in the model, the analysis of the current state is crucial to the entire implementation and therefore marked as the very first step of the integration process. The three squares attached to the step *current state analysis* show the different sub-steps that are part of this initial analysis and affect different areas of a company: 1) Dark gray areas include measures that affect human resources, 2) medium gray areas show sub-steps that involve the technological aspect of the learning integration and 3) light gray fields show what kind of changes in regard to the overall company organization need to be considered. By taking the three areas human, technology and organization into account, the designed integration model also includes the multilateral approach to analysis of the so-called Mensch-Technik-Organisations-Analysis (MTO, human-technology-organization-analysis) as developed by STROHM & ULICH [45; 46]. The consideration of the three affected key areas and the differentiation of necessary sub-steps ensures that the process of integrating technology enhanced learning options into a company´s work processes does not overlook important factors and is aware of the fact that a change of this kind has consequences for all departments.

The status quo analysis includes a thorough and sound analysis of the current employees' competence levels, the analysis of the already implemented technologies as well as the organizational and especially the learning culture. Competence monitoring should be a continuous process and could be done with the competence matrix

which was developed by HEYSE & ERPENBECK [47]. Implemented technologies like manufacturing execution systems (MES), enterprise resource planning (ERP), service management systems (SMS) communication tools like social software applications as well as technology enhanced learning tools like knowledge management software or dedicated learning tools as mentioned above should be analyzed and evaluated concerning their benefit and compatibility. Finally the organizational structure and its culture play an important role. A tool to analyze the organizational culture is provided by DENISON [48]. Unfortunately the evaluation of corporate learning cultures had much less attention in recent years' research. An idea can provide the contribution of MARSICK & WATKINS [49] or the quite general classification in the four fields discretionary, lean, taylorist and simple applied by LORENZ & VALEYRE in their cross country study of 15 European countries [24].

Once the status quo has been successfully analyzed, the second step of the integration process is the *definition of objectives and requirements*. This step is fundamental because without the identification of the desired target group and the learning needs, a selection of the best suitable learning enhancing technologies and the discussion of the possible development potential the technology implementation lacks clearly defined targets. It is likely that the motivation of members of staff to participate and accept the new learning strategies is affected by this and that it is higher if the implementation ambitions are clearly defined and communicated as such.When choosing a technology enhanced learning form it needs to be taken into account that not every learning technology is suitable for every organization. The decision for a particular work based learning scenario depends on various influencing factors describing the companies' internal and external settings. These influencing factors, which need to be evaluated for the implementation of learning enhancing work designs, are the current human resource development, the existing technical infrastructure, the learning culture, the already existing technology enhanced learning forms, the work tasks of the employees at question, the work organization, the level of experience based knowledge as well as existing organizational learning processes. These parameters are the main factors in learning enhancing work design and influence the selection of suitable technology enhanced learning forms significantly.

After the definition of the target group, the desired goals and the most suitable learning strategies the actual technology enhanced learning concept needs to be designed. This *design of the learning concept* presents step three of the integration model. The technology design has to take motivational incentives as well as didactic teaching methods into account. Furthermore, the design should ensure that the employee receives only relevant information and that this is presented as simple as possible but as detailed as needed. In order to achieve this, the technology enhanced learning system needs to be adapted and personalized for its different users. Consequently, individualized user profiles as well as person related information need to be part of the technology enhanced learning system [50]. Again, this step equally affects the areas members of staff, technology and organization, which is why numerous sub-steps need to be taken. One of the most important ones is the sub-step regarding the overall organization (light gray): transformation roadmap and appointing change agents. A transformation roadmap serves as a guideline during the entire implementation process – it allows to constantly check on the implementation progress, to compare the desired results with the actual milestones achieved and to integrate the learning technology efficiently and focused. To do so, change agents need to be appointed – members of the team who overlook the process and help when needed.

Step four contains the actual *concept implementation*. For this, the employees need to be briefed, the learning technology needs to be fitted to the existing IT-systems (if necessary, changes/updates need to be made) and the before mentioned sub-steps need to be organized and carried out. Here experience has shown that nearly never technology enhanced learning forms can be implemented without any adaptations to the company at hand.
Afterwards, the learning outcomes of the technology enhanced learning system need to be evaluated in a final step of the integration process *Controlling*. The success of the implementation can be evaluated from the perspective of the employees, the information technology department, the industrial engineering as well as the management. The most important influence factor regarding the success of a learning technique is user participation. No learning theory and no learning concept can truly achieve results if the employees do not use it on regular basis. User activity therefore is crucial, regardless of whether or not the implementation process

followed strict guidelines or whether or not the requirements of a learning enhancing work design were taken into account. New technologies can cause significant acceptance problems. This needs to be considered when a learning technique is to be implemented. Hesitations or acceptance issues can be prevented by involving the future users in the actual design of the technology enhanced learning thus offering the chance to eliminate possible sources of irritation before they occur. Especially the security of private data is a common user concern. If the companies' employees are involved in the design of the learning technique and see how their data is stored and encrypted, this issue can be resolved. Nevertheless technology enhanced learning forms offer also manifold opportunities to derive learning outcomes by integrated testing and monitoring. Once a detailed check regarding the success of the integration has been made, it is possible to derive further improvement measures and start the process all over again: A new current state analysis, another definition of objectives etc.. The process of integrating technology enhanced learning concepts into a company´s work flow is not necessarily one that is fully completed sooner or later. Moreover, this process is a continuous one and can only benefit from repetitive status analysis and objective adaption.

The introduced implementation model can be exemplified with the help of use-cases carried out in the framework of the project ELIAS, which is funded by the German Federal Ministry of Education and Research. This project, which stands for *Engineering and mainstreaming of learning enhancing industrial work systems for the industry 4.0*, aims to support companies in implementing new learning enhancing work systems and therefore will cover a unique challenge to deal with challenges caused by the digitization of industrial production and services. The FIR – Institute for Industrial Management at RWTH Aachen University accompanied five use cases within the framework of ELIAS. Exemplarily two use cases in the automotive sector were selected for the present paper.

The first case includes HELLA KGaA Hueck & Co., an international active company specializing in innovative light installations and vehicle electronics with 35.000 employees. At the moment, two trends clearly define the company: First, the demand for qualified technical specialists grows further and further because of the rising complexity of machines and the ongoing automation of production and installation processes as well as controlling measures. Second, the average age of employees increases in its main production sites in Germany. The work systems in the area of accelerator pedal sensor production and SMD production that are part of the ELIAS project research are already characterized by a high degree of automation and high product complexity. In order to have better control over operating devices and production processes and take work load off of the technical service, technical specialists receive specific training. This training aims to improve their flexibility, their understanding of the system as well as their decision-making skills. A technology matrix was created with the help of an analysis assessing the need for personnel, current process workflows, information demand and knowledge flow. The matrix demonstrates which competencies are necessary for which production lines. Because of this, so far undetected needs for further qualification were discovered. Based on the results of this analysis and matrix members of staff can be trained systematically. In addition to this, the overall qualification level of employees can be raised as desired or harmonized to a specific degree. The range of tasks of employees can also be gradually extended. This concept of qualification allows for a systematical training of members of staff to so-called high-level specialists in the area of technology. They are characterized by the ability to find solutions for a broad spectrum of tasks. This means that high-level technology specialists as well as the common technology specialists can be appointed for various different areas and take over different trouble-shooting or repair tasks. In addition to that a mobile application for smartphones which enables failure analysis, failure documentation and easier solution finding was developed for learning purposes. Employees were asked concerning their requirements and the idea was to establish a basic tool which in the beginning contains the most important production failures affecting downtime of production facilities. One of the crucial success factors to be determined was to establish feedback processes and give employees the opportunity to improve continuously the instructions. Thus, machine down-time is reduced significantly.

The second use-case includes the FEV GmbH, an internationally active company specialized in engineering solutions. The company constructs and develops engines for all kinds of vehicles and employs approx. 4.000 people. By taking part in the ELIAS project, the FEV GmbH aimed to conceptualize software solutions for

application processes of electronical controlling devices within automobile engines. These software solutions are necessary because electronical controlling devices get more and more complicated nowadays, thus requiring software-supported application tools to collect calibrate and analyze measured data. The duration of training in the area of software applications is approx. 2 years. Shorter development cycles and increasing complexity of electronical control units require a continuous training of engineers. At the same time, FEV GmbH employs more and more personnel in this area, to meet the high demand of statutory requirements. The effective and efficient transfer of knowledge plays an important role when it comes to the training of staff members for new areas and tasks. In the framework of the ELIAS Project, the FEV GmbH develops a concept for a learning enhancing cognitive assistance system for the applying of vehicle engines. By doing so, new members of staff acquire the needed skills for the analysis of data and model-based calibration quicker and long-term members of staff learn easier how to use the software. Based on expert knowledge of lead users, a software tool was created that visualizes processes and can guide personnel step-by-step to the solution of a task. Because of the automation and standardization of routine processes, these tasks can be taken over by new employees in the future.

For the development of these different assistance systems, HELLA KGaA Hueck & Co. and FEV GmbH went through all of the integration steps shown in the model presented in this paper: They analyzed the current situation and the problems that needed to be solved – for all three key areas mentioned before (humans, technology and organization). Afterwards, the companies defined the targeted objectives, designed the actual learning concept and implemented it. A continuous feedback-loop ensures detailed evaluation of the success of the project.

## 5 Conclusion

The implementation of learning processes into the daily tasks of employees will be will be a key concept to ensure employability, productivity and transformation capability of members of staff and the companies they work for in the future. Workplace learning will therefore play an important role in the work routines of tomorrow, in times where economic, technological and demographic changes constitute major challenges for companies and employees. The core competencies needed for the industrial transformation due to digitization will be organizational flexibility and innovation capability. Technology enhanced workplace learning constitutes a viable and promising way to ensure companies' competitive edges as well as long-term employability of people. In the future, lifelong learning will become more and more a prerequisite for companies' success. So far, a variety of different technology based learning concepts exist. They all aim to include learning into the daily work tasks of employees. However, implementing these technologies is not something that can be done fast or taken lightly, because it involves different groups of participating players. The present paper therefore presents an implementation model that shows how to decide what kind of learning method is best suited for specific company goals and how this technique can be implemented step by step.

However, it is only a rough model that focuses on the overall picture of the implementation process and could and should be detailed further in upcoming studies. The main obstacles mentioned in this paper regarding the choice and implementation of technology based learning also need to be researched more. Only if these can be solved, technology based learning concepts can help companies and employees to constantly evolve, learn and grow and thus be qualified to deal with tasks in a highly digitized and competitive working world.

Both cases show possible company reactions to the increasing complexity. They both have in common that digital tools are used to assist during a specific task and that they are also used to address personal and organizational learning. It becomes obvious that learning enhancing technologies need to be adapted to the very different circumstances companies and their departments are acting in. In addition to that the development of any assistance system needs to be coordinated with necessary changes in the work organization to really benefit from workplace learning. Thus work organization should also take into account to provide employees sufficient scope for learning. Finally learning culture will become one of the decisive factors in coping with the ongoing digitization.

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