Successfully developing workplace-related skills using digital assistance systems

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1. Digitising the world of work as a driver of new opportunities for developing workplace-related skills

In the "Future of Jobs Report 2020", 94 per cent of the managers interviewed stated that they expect their staff to carry on with further training programmes and continue gaining new qualifications. Apart from the high percentage, it is the increase when compared to 2018 that is remarkable. Back then, 65 per cent of those surveyed expected their employees to continue with further training (Zahidi et al., 2020). Following the COVID-19 pandemic, the pressure on staff to gain further qualifications is rising. "Teaching future skills [1]will become more important than ever in Germany over the years to come. Even before COVID-19 took hold, disruptive business models had changed the world of work beyond recognition. The crisis resulting from this pandemic is accelerating digital change and influencing existing business models with ever greater force" (Kirchherr et al., 2020, p. 4). The survey shows that "in the short term, the focus is on the most urgent deficits in training, notably key digital qualifications, mainly in the fields of 'digital interaction', 'digital learning' and 'digital literacy'" (Kirchherr et al., 2020, p. 5).

Besides the challenges brought about by the coronavirus, the ongoing, technology-induced transformation process is one reason for increased requirements in the development of skills. At the same time, the design of the workplace is changing in this context. It is becoming more context-adaptive, intuitive, networked and supported by assistance systems (see Figure 1). This article concentrates on the increasing significance of digital (learning) assistance systems.

[1] Future skills are those skills that, over the next few years, will become ever more important for working life and participation in social aspects in all sectors. They can be subdivided into "key digital skills", "technological skills" and "key non-digital skills" Kirchherr et al. (2020, p. 5).

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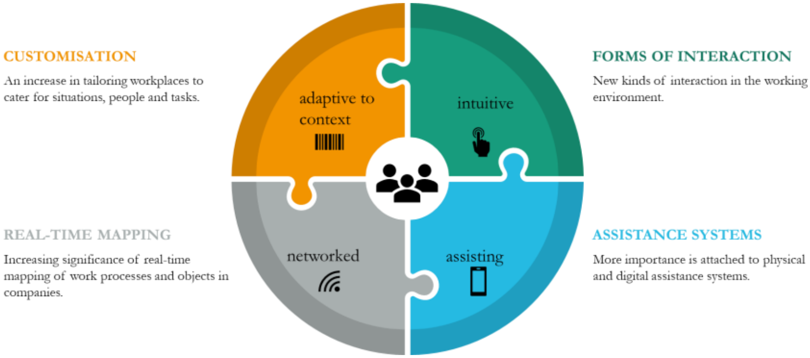

Figure 1: Workplace trends (Fraunhofer IAO)

The changing set-up of work often results in a change in the distribution of skills between people and technology and the need for adapted employee skill profiles (cf. (Ganz et al., 2019; Ittermann & Niehaus, 2018; Windelband & Dworschak, 2015)). The extensive debates in science and industry on this subject reveal both challenges and opportunities for companies. The company's goal is to design an intelligent work system that benefits from increased productivity and optimisation of resources. Technologies, such as artificial intelligence (AI), offer huge added value potential in this respect (Behrens et al., 2021). In order to develop the potential for change in terms of technical, organisational and social aspects, an intelligent learning system needs to be created at the same time that is directly linked to the work system. The use of artificial intelligence (AI) can promote needs and personnel-specific training which, at the same time, enables the improvement of the underlying technical system (reciprocal learning). The best scenario will be that both the work and learning systems are positively influenced by AI-assisted learning technology.

There has long been a debate in both research and in everyday life on the challenges posed by "lifelong learning" and "work-related learning". Digitisation and new AI-assisted learning technologies are now able to reach these goals and help staff in the sense of "learning workers" in order to improve the efficiency of developing workplace skills. Innovative learning technologies refer to new ways of developing workplace learning. With the help of new learning technologies, the previous external control of learning modules and content is expanded to include the possibility of self-governed learning that is flexible in terms of both time and location. By tailoring the learning units and making it possible to learn in different locations, it will be possible to continuously develop skills and acquire qualifications that are specific to the individual and job role (Jenewein, 2018; Sammet & Wolf, 2019; Sauter & Sauter, 2013).

Creating a work system that promotes learning can, for instance, be supported by the use of a digital learning assistance system to convey content (Pokorni et al., 2021). Corresponding digital learning assistance systems will add a learning infrastructure to work, thereby creating work-related learning spaces in which a person can learn in a self-controlled and self-determined manner (Dehnbostel, 2020).

"Digital learning assistance systems" is a term that comprises, on the one hand, digital assistance systems that are used primarily to assist with work, and also include functions for imparting information and further training. On the other hand, digital assistance systems are created and used solely for further training within the company and without having an assisting function in a person's job. A study revealed that roughly one third of the companies surveyed stated that they use learning assistance systems with the aim of getting their staff to gain further qualifications on an ongoing basis (Klapper et al., 2019).

This article aims to highlight the potential and challenges of digital (learning) assistance systems for workplace-related learning and to show the extent to which the introduction of corresponding systems can lead to further training in the workplace. We will initially present the joint project "TransWork" and the investigation that was carried out as part of the project (Chapter 1.1). This is followed by a sketch of the criteria for developing a successful introduction process with corresponding learning assistance systems (Chapter 1.2). Finally, the question will be examined as to the role that can be played by artificial intelligence (AI) in in-house further training measures (Chapter 2.1) and the challenges currently confronting the creation of AI-assisted learning (Chapter 2.2). Chapter 2.3 looks at two possible research and development projects. Finally, the development and planning of symbiotic interaction (human-machine) are examined in Chapter 2.4 and the ways in which mutual reciprocal learning in the interaction between humankind and assistance systems are analysed. The final section looks at the conclusions which can be drawn, offering an outlook on the development of workplace-related skills featuring artificial intelligence (Chapter 3).

1.1. The use of digital learning assistance systems

As part of the joint project "TransWork"[2] (TransWork - transformation of work through digitalization), research was carried out on digital tools and assistance systems. Here, digital assistance systems were investigated in terms of both their use as a working tool as well as their potential as a learning aid.

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[2] The "TransWork" project was funded by the Federal Ministry of Education and Research under the "Work in the Digitalized World" programme (funding reference 02L15A160) and supervised by PTKA, an independent service unit of the Karlsruhe Institute of Technology. The responsibility for the content of this publication is retained by the authors. For more information, please go to: www.transwork.de.

The objective of the research carried out was to develop decision-making tools that primarily assisted those responsible for the standardisation process in assessing, selecting and reintroducing digital assistance systems.

The following topics were investigated:

- What digital learning systems are employed for which areas of use?
- What success criteria are key to introducing and using (learning) assistance systems?
- How is work transformed by the introduction of assistance systems (this does not constitute a part of this article, please see (Bauer et al., 2021; Link, Schnalzer, & Hamann, 2020))

As part of the TransWork project, a working definition was created first of all, which reflects the diversity of the different types of digital assistance. Accordingly, digital assistance "systems are computer-based systems that assist people with information intake (the way they perceive it), processing the information (decision-making) and carrying out work. A difference can be made between the extent, type and goals of support" (Link & Hamann, 2019, p. 684) in accordance with (Apt et al., 2018; Blutner et al., 2007; Busse et al., 2018; Link & Hamann, 2019).

In twelve collaborative projects from the main funding source "Work in the Digitalized World", the procedures for the development and introduction of digital assistance systems were examined in 16 use cases[3]. Here a digital assistance system was used in one use case primarily as a learning tool, in six use cases it was used as a working tool and in nine use cases it was used as both a working and learning tool, depending on the area for which it was intended (Link, Schnalzer, & Hamann, 2020).

The ten assistance systems that offer the users learning opportunities are discussed below. An overview of the selected (learning) features of the learning assistance systems investigated is presented in the morphological box below, which was (Niehaus, 2017) expanded on the basis of, and adapted to, (Apt et al., 2018; Hacker et al., 1995) the investigation. The main points identified among all learning assistance systems investigated are in italics.

Feature	**Attribute**	
Assistance form	Learning tool	*Working and learning tool*

[3] Data basis: 15 guided interviews with company representatives from ten collaborative projects and project documentation from two collaborative projects. Evaluation: qualitative, category-guided content analysis of interview transcripts and project documents and publications.

Sector	*Industry/manufacturing industry*	Service	Construction	Different industries
Target group	*Employees without responsibility for staff*		Employees with responsibility for staff	
Learning aid	Basic information	*Advanced information*	Knowledge query	
Usage interval	Once	*Ongoing*	Selective	Periodic
Support objective	Compensatory	Retentive	*Widening*	
Qualification requirements	None		*Instruction (formal/informal)*	
Adaptivity	*No*			
Documentation of learning success	*Yes*		*No*	

Table 1: Features and attributes of the ten digital learning assistance systems that were investigated (own source, *note: all stated attributes were found at least once in the assistance systems under investigation)

The evaluation showed the diversity of the possible applications (learning/training), the set-up (learning assistance/learning and work assistance) as well as the objective (basic knowledge/further information/knowledge query/documentation of learning successes) in different sectors (industrial/service/construction/industry-independent).

The digital learning assistance systems that were surveyed are mainly used for ongoing further training. This is shown in the characteristic attribute *further information* as the predominant learning aid, an *ongoing* usage interval as well as a support objective of expanding knowledge.

However, the learning assistance systems also partially provide support for *retaining* existing knowledge or for *compensating* for gaps in knowledge. Depending on the situation at work or the person using the assistance system, it can be used either *selectively* (with problems), *periodically* (regularly for recurring working processes) or to enable new members of staff to *learn the ropes*. The latter option allows the standardised preparation of information via the learning assistance system, in order to convey relevant aspects of work activities in a comprehensible manner and to ensure complete initial instruction. Most of the digital learning assistance systems observed are used at work on an *ongoing* basis. None of the learning assistance systems examined was able to cater to the member of staff *adaptively*, e.g. by adjusting the speed at which it was delivered. According to information provided by the interview partners, a brief in-house *introduction* (formal or informal) is required in most cases, in order to use the learning assistance systems. In fact, some of the learning assistance systems can be operated intuitively, and do not need any briefing. A formally organised training session, for instance by outside experts, was not required in any of the cases surveyed (Link, Schnalzer, & Hamann, 2020).

The criteria relevant for success with the introduction of the digital assistance systems from both a company and employee perspective for the surveyed projects and the learning-specific prerequisites will be examined in the next chapter.

1.2. Planning aspects for the successful introduction process of digital (learning) assistance systems

Success and inhibiting factors were identified across all sectors during the investigation of the introduction process of digital assistance systems (irrespective of whether learning or working tools). The results were not surprising. They reflect estimates which are known from the introduction procedures of other IT systems or automation projects (see comparison (Ganz, Kremer, et al., 2021)). Here, there still appears to be a lack of transfer of scientific findings into entrepreneurial practice.

To summarise, the following assessments concerning the success in introducing digital assistance systems can be deduced from the study:

1. The availability of a technical infrastructure, such as the connection of the systems to an existing IT landscape, is a fundamental factor in the success in the introduction. Furthermore, the company-specific choice and adaptation of the required hardware and software is an important task which can also have an effect on the acceptance of the new systems by staff.

2. If staff are involved in the choice and introduction, the technical, organisational and social requirements for the system can be detected at an early stage and incorporated into the selection (requirements and needs analysis). This means that domain experts, staff from the HR and IT departments as well as the works council must be involved (interdisciplinary project team). A pilot project provides the ideal opportunity to test the new system as well as obtain feedback on the functions and procedures, so that mistakes and challenges can be detected and eradicated before the system is rolled out in certain departments or throughout the company. In such a test and trial phase, 'multipliers' can also be trained to pass on their experience and impart knowledge about the system to colleagues in the event of a wide-scale introduction.

3. Another aspect for the successful introduction of digital assistance systems is, on the one hand, the qualification of the project team, which needs to have the technical, organisational as well as methodical knowledge, in order to assist in the selection and implementation of the learning assistance system. On the other hand, thought needs to be given to ensuring that staff are qualified for the new system. In spite of the demand that the assistance systems are easy to operate and can be

used intuitively, not all assistance systems can be operated by every member of staff. This means that, in addition to creating acceptance and willingness to use the system, it is necessary, first and foremost, to check whether instruction in the system is required (qualification and development of skills) (for further TransWork results, please see (Link, Schnalzer & Hamann, 2020); for criteria from reference works, please see as an example ((Deutsches Institut für Normung e.V., 2019; Klapper et al., 2019; Sauter & Sauter, 2013; Schenk et al., 2016)).

4. When introducing learning assistance systems in particular, the survey showed that is necessary to check the existing work organisation and processes for the existence or creation of learning periods. It is often the case that employees do not have enough time for further training during their normal working hours. Whereas, for instance, there are generally fixed and mobile end user devices in assembly areas, active breaks can be created here for workplace learning due to the high clock rates and production specifications. In other sectors, for instance in the care industry, there are none or hardly any digital assistance systems around that could be used to aid learning. At the same time, our interview partners from the collaborative projects also stated that there is hardly any time to learn during working hours because of the number of tasks that need to be completed. Learning takes place during off-peak times or after work.

Learning by means of digital learning assistance systems can only take place if learning incentives are in place during normal working, learning periods are available and can be taken up by the individual and learning certificates are recognised. Factors to aid learning that are most often used during the introduction are summarised in the following Figure 2.

Figure 2 Steps for a successful introduction process (Fraunhofer IAO)

The introduction of digital learning assistance systems with artificial intelligence to help the functions is a way to offer employees tailored help in the learning process. As already shown in Table 1, none of the digital learning assistance systems from the funding priority has adaptive functions that aid customised learning. In future, artificial intelligence will enable learning to become faster, simpler, more effective and more efficient with the help of automated evaluations of learning behaviour and needs as well as tailored learning paths and learning content.

The following section takes a look at the question as to what extent artificial intelligence is already integrated in further training methods and the potential and challenges posed by this technology.

2. Artificial intelligence as a supporting learning technology for workplace-based learning

The possible use of artificial intelligence (AI) in learning systems is gaining importance in both science and industry. AI-assisted learning systems have the advantage that both the learning process and content can be compiled and planned for the individual according to their needs. This results in highly personalised and efficient "on-the-job" training.

We now wish to present current trends in AI as a learning technology and to illustrate the possible ways in which AI-aided learning can be integrated into workplace learning. We will then move on to outline potential opportunities for and current challenges in using AI as a learning technology aid.

2.1. Use and potential of artificial intelligence in further training programmes

Researchers have been working on the use of AI to support learning processes since the 1970s (e.g. (Aleksander et al., 1990)). It now seems that the technological maturity of AI has made a practical implementation possible in (adaptive) learning systems.

A study by Siepmann shows that AI has found its initial applications in vocational training. Around 34 per cent of companies stated in the benchmark study that they have or are planning different methods, such as adaptive training systems. The analyses also show that there was a significant increase in both actual and forecast figures between 2019 and 2020 (Siepmann, 2020). According to assessments in the HolonIQ Artificial Intelligence & Global Education Report, AI is the fastest growing education technology and will be used extensively throughout the world (primarily in the USA and China) over the coming years (HolonIQ, 2019). This use is backed up with considerable potential for development across all sectors (Pinkwart & Beudt, 2020).

The term "artificial intelligence" includes different technical processes and extensive potential for applications when viewed as a learning technology. In a survey of companies carried out in 2020 by the mmb Institute for Media and Competence Research, in which they were asked what role different AI technologies would play in learning programmes over the next three years, roughly 39 per cent of respondents saw AI-aided learning analytics and adaptive learning as being "very important" (mmb Institut – Gesellschaft für Medien- und Kompetenzforschung mbH, 2020). This shows, on the one hand, the relevance of AI support for improved learning forecasts in the field of further education. On the other, the results show that, above all, learning paths tailored to the learner's requirements are a required function in further training (Siepmann, 2020).

When planning an AI-based learning assistance system, a closer look must also be taken at the application level. A difference must be made in training between granularity and the target group. For instance, Pinkwart & Beudt differentiate between the micro-, meso- and macro-level (Pinkwart & Beudt, 2020).

	Learner	**Trainer**	**Organisation**
Micro-level	Adaptive training software	Task to determine the level of difficulty of the training programme	Dynamic availability of resources, e.g. learning content
Meso-level	Monitoring one's own learning success	Analysis of group learning processes	Assistance in the time it takes to plan a training programme
Macro-level	Long-term ePortfolios, fit to job profiles	Further development as a trainer, lessons learned as regards factors of success	Monitoring of qualitative aspects and revision of training programmes

Table 2: Training application scenarios using AI (according to (Bernd et al., 2020))

If AI is used to assist detailed and specific training and learning processes for specific time periods at the micro-level, the use of AI at the meso-level is geared towards the use in medium-term learning scenarios with automated analyses of learning results. These can then be used to identify individual learning patterns and to develop adaptive learning systems. (Pinkwart & Beudt, 2020, p. 8) explain that AI-aided assistance technologies [are located] "at the meso-level of AI assistance […] that are not specifically tailored to the training context but which can be used there, such as text-to-speech generators or image recognition software […] or other digital assistance systems geared to the specific topic that is not primarily intended for short-term training purposes, but rather e.g. used as integrated learning and working tools in the medium term". This assessment also coincides with the responses from the companies that were studied during the TransWork project. They, too, emphasised, that they were looking for assistance solutions, in particular, ones that could be used as both learning and work tools.

At the macro-level, AI technology can, for example, help in the strategic planning of further training strategies and modules to develop goal-oriented, workplace-related skills.

2.2. Challenges in creating AI-based learning

The authors stress that nowadays systems are used mainly to assist with specific learning processes in integrated learning and assistance systems (at a micro- and meso-level) (Pinkwart & Beudt, 2020). Nevertheless, the potential of ongoing use (macro-level) appears to be extensive and could be used in designing courses (e.g. use of a hybrid approach – human-AI methods), technically (e.g. adaptive micro learning programmes) and by HR departments (e.g. course certificates). One reason why these assistance systems have not been used to a great extent at the macro-level to date is the so far hardly fulfilled prerequisite that available training content is available in a modular and fine-grained manner, meaning that a lot of work will have to be done first to support the customisation learning content and formats for the individual. Moreover, adaptive training courses require precise domain models, automated evaluations of the learning solutions as well as didactic models that are technically feasible. Here the technical and didactic development is still in its infancy (Pinkwart & Beudt, 2020).

If the use of AI-aided learning assistance systems offers the possibility to create further training courses with greater efficiency, this then meets with criticism on the part of both learners and trainers. It is primarily the dominance of AI over the education process and thus the restriction of a free and a self-determined learning process that is viewed critically. Where previously mainly "classic" AI-aided training technologies were created based on rules and knowledge, statistical machine learning methods are currently being tested and used. However, the methods mentioned above and the ensuing control over the learning process are difficult for the learner to understand. As the control and understanding of the learning process are of elementary importance for the learner, as are the learning assistance systems used, it is to be expected that primarily hybrid, cognitive AI methods will link data-driven findings with knowledge-based explanations in the future. Consequently, a learning process is then created which is transparent and logical, so that the learner understands how the respective learning paths and content have come about.

AI-aided learning processes are both expanded and made more complex by the learning aspect of AI in the process. Statistic/learning AI training technologies are based on extensive user data generated via machine learning. System models are continually improved by means of educational data mining procedures using AI-aided learning assistance systems. This results in the opportunity to train both the technical system and the human learner (Pinkwart & Beudt, 2020).

The success factors described in Chapter 1 for the introduction process of digital assistance systems to assist in developing workplace-related skills also apply to the technical expansion of systems by means of artificial intelligence. This is shown for example in the study by (Siepmann, 2020), where companies state the reasons why they are against the use of AI, notably the current state of technology, the complex implementation or non-compatible infrastructure, data protection and security as well as the concerns of management, works council and HR department.

Consequently, we wish to refer again to the experiences gained from TransWork: the early involvement of those who will be using the system and key stakeholders (i.e. board of directors, management, works council, HR department, IT) promotes both the acceptance as well as the willingness to use when implementing AI-aided assistance systems.

We would like to point out here that, regarding the success factors of introducing innovation projects such as e.g. assistance systems, there is often a gap in the transfer of knowledge, especially among SMEs. This is not only evident in the introduction of digital (learning) assistance systems but also when it is a matter of introducing AI solutions in the company (Bauer et al., 2019; Ganz, Friedrich, et al., 2021). Research offers numerous guides on the human-centred introduction of digital assistance systems. In this context, it is necessary to examine the transferability potential of these guides to the topic of AI and to broaden criteria specific to the topic such as, for instance, how to explain the ways in which artificial intelligence works. In addition, new and innovative transfer formats need to be developed. One example of a new and successful transfer format is "Popup Labor BW"[4]. The pop-up lab is a temporary workshop where companies, especially SMEs, can learn about new technologies. It is low-threshold in its approach and takes place in different locations around the federal state of Baden-Württemberg (BW).

2.3. Current examples of research and application

As previously mentioned, the topic of AI-aided assistance systems for supporting workplace-related further training programmes is becoming increasingly the focus of various research and development projects. Two project ideas are outlined below as examples to illustrate, in particular, the breadth of potential in the application of AI for developing job-related skills.

One example is the NAWID[5] project funded by BMAS on the "use of AI-aided assistance and knowledge services in company-specific training spaces, taking into account heterogeneous worlds of values in demographic change". Digitisation

[4] https://www.iao.fraunhofer.de/de/forschung/organisationsentwicklung-und-arbeitsgestaltung/popup-labor-bw.html

[5] https://www.nawid-projekt.de/dasprojekt-ziel/

prompts increased demands on the willingness of employees to change and internal and external qualifications. Lifelong learning will be required even more, and the respective content will need to be made accessible according to context, while, at the same time, references to the context will continually be redefined. Consequently, a high degree of flexibility will be needed in terms of providing learning programmes. The project addresses two core areas of action and structure in companies: cultural change in the digital transformation and key issues of demography in work and qualification processes. In learning and experimental spaces, the introduction and use of assistance and knowledge services as well as applications of artificial intelligence are tested in the project by means of models and examples.

The joint model development and testing of AI systems in this research project is carried out for various use cases that address tailored learning in the office and on the shop floor. In one application case, for example, a knowledge-based system is developed and tested that is intended to provide adaptive learning support at the micro-level. The systems extend an e-learning programme already in existence by adding user-adaptive support material that is intended, in particular, to monitor and manage the learner's own learning process (e.g. the learner reflects on their learning progress, checks their own understanding of the learning content that has been presented). As a result, the system supports self-organised learning, which is particularly relevant for workplace and lifelong learning scenarios.

ARIBUS is one of the partners actively involved in this project. In this use case, the transfer of knowledge geared towards a particular activity in the workplace in relation to "Industry 4.0" is explored and implemented as a pilot project with the help of a new learning environment. Basically, this is intended to help in training and learning a complex assembly process. Supporting adaptive learning is achieved by the fact that the system combines relevant domain knowledge as well as information on the learner's individual skills and previous experience with data-based analyses (e.g. sensor-based recording of the learner's interaction with the system, component movements, etc.). The system is then supposed to recognise the learner's issues and offer help in real time. When developing the components necessary for the hybrid AI system (e.g. domain model, didactic knowledge, fine-grained learning materials) collaboration was undertaken with employees, members of works' councils as well as trainees and apprentices, in order to incorporate their practical knowledge into the development of the system (see www.nawid-projekt.de as well as (Pinkwart & Beudt, 2020)).

The second example presented here is an R&D project from the AI Innovation Centre "Learning Systems and Cognitive Robotics", an initiative of the Fraunhofer-Gesellschaft applied research organisation[6]. The Stuttgart-based Fraunhofer

[6] https://www.ki-fortschrittszentrum.de/de/projekte/dafne.html

institutes IAO and IPA work together with companies on joint projects, in order to implement AI technologies on a broad scale into the manufacturing sector and service industries. In this context, the Fraunhofer Institute for Industrial Engineering (IAO) worked together with Trumpf, a German industrial machine manufacturing company, on AI support for field representatives and developed a prototype of a digital assistant for field representatives to optimise administrative tasks.

A field representative is confronted with numerous tasks during their daily routine, irrespective of the sector in which they are employed, from the preparation for and the follow-up of a customer meeting, to the development of new customer and product-relevant information as a result of taking over a new sales region or the launch of new products. Scenarios were developed and assessed in collaboration with the project partner Trumpf, in order to make these tasks more tangible. Incorporating AI into the task of "documenting a customer meeting" was seen to be especially useful and important. This work often takes place in the evenings, when reports and records of meetings are written up, e-mails sent as well as other administrative tasks.

A dialogue-based language assistant with a control function is intended to improve the situation for these tasks, insofar as it records all relevant customer information and key points of the meeting immediately after the meeting has taken place by means of AI-aided voice input (see Figure 3). Notes are then transferred into the CRM system after they have been manually checked. When the voice input is finished, the subsequent AI-aided activities like forwarding praise, sending product information or suggesting follow-up meetings are then carried out.

Other AI-aided assistance functions such as e.g. preparing suggested e-mails to send to the customer based on previous meetings and the customer profile in question form part of the concept. In addition, an intelligent link with the address stored in the database is intended to create dynamic suggestions for customer meetings in the vicinity of where the field representative has their next sales call.

Consequently, the digital assistant is supposed to help the field representative to use add value to the time spent on administrative tasks supported by AI. The assistance system allows the field representative to carry out admin and communication tasks easily at any time, whether in the office or out on the road, and saves up to 10 to 15 per cent of their time as well as reducing the workload.

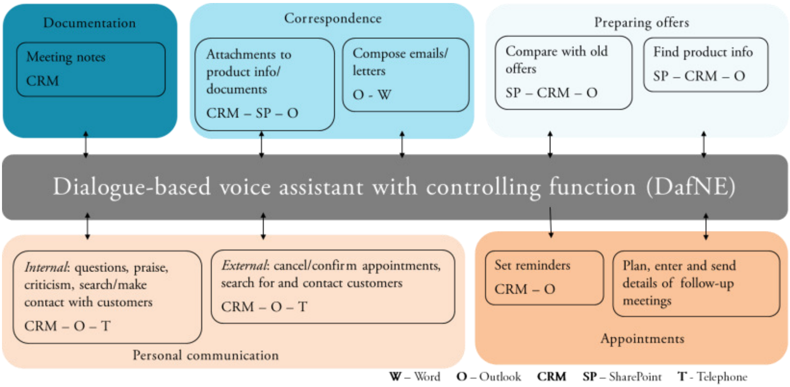

Figure 3 Digital assistant for field representatives to optimise time spent on administrative tasks (Dukino, 2021)

Besides these functions, ideas are currently being discussed as to how this assistance system can be further developed. For instance, it is feasible that the assistance system could provide brief learning units for the sales representative to listen to on their journey to a customer meeting. With the help of so-called "learning nuggets", the employee would be presented with information such as minutes from the previous meetings, new company or product information that may be of interest to the customer, or products manufactured by the target company. This lets the employee recall important information which they can put to good use during the customer sales call and the customer feels appreciated (Dukino, 2021; Link, Dukino, et al., 2020).

As shown in the examples, various scenarios and prototypes are currently being developed and tested, such as creating new functions in assistance systems where the use of AI adds value. This naturally includes the fact that Research and Development are increasingly concentrating on AI as an aid in learning technology. One topic on which Research and Development has recently focussed their attention is the potential of developing digital assistance systems that encourages two-way, reciprocal learning.

2.4. Reciprocal learning during the work process

The catchphrase "specialisation scenario" or even "tool scenario" was long favoured as the model in which emphasis was put on the fact that technical innovations should support people and not substitute them or make their tasks redundant (Windelband & Spöttl, 2011). Possible solutions are increasingly being explored in line with the technical progress of AI as to how artificial intelligence can support the symbiotic interaction between employees and machines (assistance systems). Symbiotic interaction aims to form the assisting functions of artificial intelligence in such a way that it helps humans to accomplish highly complex tasks carried out at work (Daugherty & Wilson, 2018), thus allowing reciprocal learning to take place, where both the "learning system" and the person achieve added value – the learning system by expanding and improving its databases and the human through the working and thus learning environment, which is conducive to learning and, above all, is individually tailored to the individual's requirements (Huchler et al., 2020).

A categorised table of man and AI interaction was compiled by Huchler and based on previous studies such as levels of autonomy (Ahlborn et al., 2019), with an assessment of the interaction between man and artificial intelligence. The scores given were on a scale from 0 (poor quality of interaction) to 1 (high quality of interaction) (see Table 3).

Stage	0 Man	0.5 partly man	1 Man & AI	0.5 partly AI	0 AI
MMI quality	MMI poor quality	MMI mediocre quality	MMI high quality	MMI mediocre quality	MMI poor quality
Learning	**Split learning:** The human learns separately from the technical system, the quality of machine learning is not improved by MMI	**Asymmetric learning I:** The human's knowledge and experience are not used to improve the system's learning process; corrections are only done on a sporadic basis	**Reciprocal learning:** The MMI is configured to promote the learning aspect, meaning that the system and human help each other to learn; high degree of learning quality	**Asymmetric learning II:** The system learns separately, the human can only manipulate the technical learning process, and learn in the best case either by chance or autonomously in the process of using it.	**Hindered learning:** The system learns "behind the scenes", the human factor is irrelevant

Table 3: Potential learning scenarios in human-AI interaction (Fraunhofer IAO in accordance with (Huchler, 2020))

According to Huchler, poor quality interaction occurs either as a result of "split learning", where the human is learning but the system does not experience any improvement, or during "hindered learning", where the system learns in the background but the human factor is in danger of being made redundant. The aim should actually be to create a dynamic learning relationship between the human and the machine, in order to improve both human and machine skills (Huchler, 2020). "Here the AI systems learn on the basis of explicit human instruction or by observing human actions, whilst the human can learn at the same time by using precisely those AI tools" (Pinkwart & Beudt, 2020, p. 17). This type of workplace-related learning is also referred to as "two-way" or even "reciprocal" learning (Mayrhofer et al., 2019).

Initial technical applications are currently being developed and tested in pilot projects and pilot plants. Apart from collaborative robots, digital assistance systems can be used, for instance, for assembly and servicing, to test different learning scenarios. Researchers at Vienna University of Technology (TU Wien) studied split tasks between assembly workers and collaborative robots in the "Industry 4.0" pilot plant, thus testing various learning scenarios between humans and machines. In this way, junior workers were able to learn from both senior staff and cobots, while the cobot learns how to handle new fault scenarios from either senior staff or other cobots (Mayrhofer et al., 2019).

3. Conclusion and outlook on using artificial intelligence to develop workplace-related skills

The introduction outlined how work will develop in the future. It will get "smarter" (cf. Figure 1). New forms of interaction between humans and technology will fundamentally change the way we work everywhere. Learning systems, robotics and virtual as well as augmented reality mean that work and business processes will be mapped transparently in real time in the future. Nevertheless, it is only the targeted combination of new technologies, modern organisational and work structures as well as qualified and motivated staff that will enable the full potential of this transformation to be realised.

This transformation process will change the skills required from employees. Besides creating a basic understanding of technology, in order to assist in the acceptance of the use of AI, an understanding of processes and systems as well as the establishment of new skill profiles (roles) will be necessary. Training programmes will be required that are geared more towards specific target groups and particular needs, the content of which is supported by user-centred learning assistance systems.

Greatest potential is seen in the partnership between humans and machines in the sense of a symbiotic interaction. In contexts of education, hybrid human-AI systems are becoming increasingly important, and AI can be integrated into existing training systems significantly more than used to be the case (Pinkwart & Beudt, 2020). The goal should be a differentiated approach towards the building up skills. On the one hand, it trains employees in understanding and handling AI applications, including further training, and, on the other, educates employees, who are concerned with the development, training and updating as well as adaptation and statement of performance of AI solutions (Ganz, Friedrich, et al., 2021).

As already seen, particular attention should be given to getting staff involved during the process of introducing assistance systems. This must involve the key stakeholders at the implementation stage. During the preparation of the introduction stage, it is crucial to check what skills the stakeholders have and require in order to accompany the project. One way in which stakeholders' skills can be built up is, for example, the “Learning World” in the Future Work Lab[7]. The Future Work Lab, part of the Fraunhofer IAO, is an innovation lab for work, people and technology, and exposes companies, associations, employees and trade unions to the development of future-oriented work concepts. Part of the lab is the Learning World ("Lernwelt") which serves as a skills development and advisory centre, where all employees and interest groups can get more information, obtain further qualifications and together discuss possible developments of future working environments. This includes, for instance, the impact of digitalisation, new requirements concerning skills and qualifications, latest learning concepts as well as the organisation and assessment of working environments in a way that promotes learning and is geared towards the individual employee.

However, the Future Work Lab is not just a demonstration and advice platform. Prototypal solutions are promoted, such as intelligent support via AI-aided assistance systems, with the goal of developing a workplace that represents a combination of “affective computing” (emotion AI) and a digital assistance system. The AI-aided assistance system not only recognises processed objects, for instance, during an assembly process, and delivers the information required for the working steps, but also reacts situationally to the employee’s emotions which it recognises. If the system recognises that the process is working above or below its capacity, it recommends possible countermeasures to the employee. Where the system is working below capacity, it can suggest, for example, “micro-lessons” on current company topics, and the employee can be trained at their workstation. Overall, the aim is to minimise excessive demands by means of targeted support, to avoid excess capacity, to support workplace-related learning as well as to encourage motivation and improve productivity (Wimmer & Bangali, 2021 (in print)).

The analyses carried out by TransWork have shown that a substantial dynamic exists in the application in terms of the development and introduction of learning assistance systems. Nonetheless, topics that need to be researched and developed are still apparent. Among the outstanding R&D topics, there is the question as to how emotions can be taken into consideration in intelligent educational technologies. These could then become advanced “learning companions”, which take into account the level of stress or frustration affecting the learner. Furthermore, there is potential in using AI for longer-term strategic planning and teaching and further training. Even VR-based and AR-based training technologies may benefit from incorporating AI, such as analysing activity patterns and tailored responses to activities in virtual worlds. The question remains as to how processes and methods for modularising educational content as a prerequisite for customisation can come into widespread use (Pinkwart & Beudt, 2020).

[7] https://futureworklab.de/

The aforementioned research and development topics are important fields of research that are being investigated at Fraunhofer IAO, both now and in the future.

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