Lernende Systeme

GERMANY'S PLATFORM FOR ARTIFICIAL INTELLIGENCE

Competence development for AI

Changes, needs and options for action

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WHITE PAPER

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Summary

Artificial intelligence (AI) is changing the division of work between humans and technology and thus also the everyday working lives of many employees. The use of AI systems promises great potential for employees and companies, for example through the optimization of production processes or the flexibilization of orders. With regard to employees, the introduction of self-learning systems enables work to be richer – for example, by relieving them of routine tasks, by supporting them with assistance functions, and by designing work in a way that promotes learning and experience.

In this context, a central challenge for the successful introduction of AI technologies is the early qualification and further training of employees. In all industries and domains, new competencies for the development of AI systems and in dealing with AI technologies will therefore be necessary for different employment roles. These changed competence requirements concern both technical and social dimensions.

With this paper, experts from the working group Future of Work and Human-Machine Interaction of Plattform Lernende Systeme aim to provide guidance on how competence requirements will change due to the use of self-learning systems. To this end, the authors discuss how AI competencies can be built up in a purposeful manner (Chapter 2) and which competencies will be relevant in the AI-era (Chapter 3). Central to this is that the process of competence management and development is integrated into the company's strategic orientation and is in line with the AI transformation of a company. Important issues here are recruitment, goal-oriented training, and strategic competence management. The task of competence management for AI is to define the specific competencies required for the various roles and tasks. In order to (be able to) describe the requirements, it is therefore necessary to determine contextually how AI affects the respective roles and possibly changes the interaction between humans and machines. To this end, the paper outlines steps of the competence management process as a starting point for competence development. The six steps in the competence management process include:

- Definition of (job) roles and their responsibilities in the context of AI
- Assignment of tasks within the changed division of work between humans and AI
- Derivation and definition of specific AI competencies required to perform tasks
- Definition of competence profiles for each (job) role and definition of the associated target profile
- Competence needs analysis: Assignment of employees to the corresponding competence profiles and individual assessment
- Definition of suitable further training measures for the aimed AI competence development of employees

Depending on the respective role, the changing interaction between humans and AI requires different competencies that can be divided into three categories, each of which builds on non-AI-specific competencies: first, technical and basic knowledge; second, dealing with AI systems; and third, designing the context of AI systems. Overall, measures for in-company training can be specifically fostered by working conditions that are conducive to learning and experience and can thus be implemented better.

Based on the identified competence requirements, the paper then derives three practice-oriented competence profiles serving as examples to illustrate the AI-related changes for different roles and tasks in companies (Chapter 4). These illustrated role profiles are intended to map different tasks, areas and responsibilities in a company and to analyse different work areas. For this purpose, the corresponding changes in roles and competencies are described and then visualized.

The paper aims to address the competence development in companies at an early stage. Competence development represents a central building block for the success of AI change management. In addition, AI leadership culture will also be a key success factor for the introduction of self-learning systems in companies in the future. This approach fosters a positive error culture that encourages employees to think and act independently and critically regarding AI.

1 Introduction: Objective and claim of the paper

Artificial intelligence (AI) will significantly and sustainably change the work of many employees. The possibilities of AI systems will unfold great potential for companies – in new business models, the optimisation of production processes or more flexible order design. However, the introduction of self-learning systems in companies should at the same time imply the task of using their potential to open up new opportunities for rich work for employees as well – for example through the relief of routine tasks, through the support provided by assistance functions and through their design to promote learning and experience. This new age of AI technologies has already begun: More and more companies are integrating self-learning systems into their work processes or developing completely new business models around AI technologies. Indeed, this is necessary to ensure that German companies are positioned at the forefront of AI progress within the next wave of digital technologies.

However, the introduction of AI technologies also poses major challenges for companies and employees: One of the greatest challenges – if not the greatest – will be the early qualification of employees as the basis for a successful introduction of AI systems and the design of the transformation with AI technologies (Stowasser & Suchy et al. 2020). New competencies for the development of AI systems and in dealing with AI technologies (as well as the work that such competencies change) will be necessary in all domains and for a wide variety of roles that employees assume. These competencies have technical as well as social dimensions (Anton et al. 2020): Current studies show that the demand for technology-related competencies will increase by 55 percent by 2030, and for social and emotional competencies by as much as 24 percent (Bughin et al. 2018).

This paper aims to provide orientation for companies on how competence requirements will change due to the use of self-learning systems and how task-oriented competence management can contribute to AI competence development. To this end, the authors first provide an overview of which competencies will be relevant in the AI era and then present a competence management process as a starting point for competence development.

To illustrate the AI-related changes for different roles and tasks in companies, the authors describe exemplary role profiles: These depicted role profiles are intended to represent different tasks, areas and responsibilities in a company. Using a fictitious company as an example, the selected roles are intended to cover different areas of work along a corporate or value-added structure. Nevertheless, this white paper cannot claim to comprehensively depict the diversity of the world of work changed by AI and the variety of competence requirements.

In addition, the paper is oriented towards larger and large companies regarding both the selection of role and competence profiles and the systematics of the competence development process. Nevertheless, the authors also want to contribute to systematic competence development in small and medium-sized enterprises (SMEs): SMEs can benefit from widely developed structures and process models of larger companies, such as those described in this white paper, if they adapt them to their needs in practice.

With this paper, the working group Future of Work and Human-Machine Interaction of the Plattform Lernende Systeme continues its previous work focus. Building on the white paper Criteria for Human-Machine Interaction in AI (Huchler et al. 2020b), this paper follows on directly from the white paper Introduction of AI Systems (Stowasser & Suchy et al. 2020) in companies. There, the authors describe early competence development as a central building block for successful change management.

2 Competence development as a key factor

Artificial Intelligence is lastingly changing the division of work between humans and technology. Between the two extremes – the AI system exclusively taking over tasks or the human exclusively taking over tasks – a broad spectrum of forms of cooperation arises. Compared to conventional technological developments, this is not new; every technological development has led to a change or shift in the division of work between humans and technology.

What is new regarding Artificial Intelligence is the ability of AI systems to learn, reason and decide on their own: In doing so, it enters task areas that have so far been primarily reserved for humans (Neuburger & Fiedler 2020). Thus, the use of AI systems in companies puts the collaboration between humans and technology on a new qualitative level. Certain physical and operational activities as well as cognitive tasks will decrease in importance, while unpredictable tasks requiring communication skills, creativity or reflection, and a high degree of flexibility will increase in importance: Employees will thus spend more time and resources on unpredictable tasks (Bughin et al. 2018).

In addition, humans do not only develop AI systems or use them in the work context. Due to the partially very close cooperation with the AI system, employees become trainers of the AI system in the sense of a human-in-the-loop system. This is because AI systems do not have a final "as-is" state like conventional technologies but are constantly evolving through interaction with users. Hence, new requirements arise not only in the context of the application of AI, but also in particular in conjunction with the development, control and training of AI systems. The people concerned must be empowered to meet all these challenges to actually exploit the potential of AI. Qualification and competence development are thus essential success factors for the development and use of artificial intelligence.

Artificial Intelligence
A generally accepted definition of Artificial Intelligence is still lacking. As a subfield of computer science, Artificial Intelligence attempts to implement cognitive abilities such as learning, planning or problem solving in computer systems. The aim of modern AI systems (self-learning systems) is to enable machines, robots, and software systems to process and solve abstractly described tasks and problems independently, without every step being programmed by humans (Müller-Quade 2019). In doing so, the systems should also be able to adapt to varying conditions and their environment. In this sense, artificial intelligence creates the conditions for self-learning systems. The ability of systems to learn was already defined as a fundamental cognitive ability at the beginning of AI research.

AI systems are not a homogeneous technology and can be roughly distinguished between symbolic and "non-symbolic" approaches. Symbolic approaches such as data-based expert systems represent knowledge about a specific area and enrich it to be able to automatically draw conclusions about a concrete problem. In "non-symbolic" approaches such as machine learning, special algorithms automatically provide meaningful results without explicit programming of a concrete solution path by building models from the available sample data, which can then also be applied to new, previously unseen data. A promising field of research in artificial intelligence is formed by so-called hybrid AI systems, which combine the strengths of knowledge- and model-based AI methods with machine learning. The inner workings of these systems are often easier for humans to understand and are therefore particularly suitable for human-machine interaction.

The process of competence development initially relates to the question of which competencies will be necessary or at least beneficial in dealing with artificial intelligence in the future. The aim of this paper is to derive practice-oriented competence profiles on the basis of the competence needs identified in this way. Based on the competencies identified as relevant for artificial intelligence, exemplary competence profiles are developed and concrete fields of action for the development of these competence profiles are presented.

Competencies

A closer examination of the topic of "competencies" first requires a conceptual clarification of how "competencies" are understood in the present context. In general, competencies are described as individually acquired bundles of abilities and skills that enable self-organised action in relevant and uncertain or complex situations (cf. e.g. Erpenbeck, v. Rosenstiel et al. 2007). It is therefore not a matter of simple or trivial goal-oriented action (e.g. "door-opening competence"), but rather of a correspondingly rich conglomerate of individual potentials for developing the ability to act and solve problems, even under conditions of uncertainty such as those to be expected in the context of artificial intelligence.

Analysis of future competence requirements in companies

The skills that companies need from their employees are changing as a result of new technological opportunities: Self-learning systems will be a fast driver of these developments. The description of competencies is therefore not static, but rather a dynamic process. With this in mind, the Human Resources Circle (HR Circle) of acatech – the German Academy of Science and Engineering – has developed a dynamic approach to analysing current and future competence requirements. In a multi-stage process, a guideline for company practice was developed in workshops and review loops with HR managers from the member companies of the HR Circle and after successful practical testing in the companies.

This is to be understood as an offer to the various stakeholders of the digital transformation: It is intended to enable future-oriented human resource management, maintain employability, and promote innovation and good work in Germany (see Jacobs et al. 2021).

The developed process of the competence needs analysis is divided into five steps. For a better understanding and easier handling of the approach, each of the five process steps is underpinned with optional aids for practice ("canvas"). In addition to key activities and central questions, these also address tools and decision-makers that may be decisive for the respective phase. With the help of this multi-channel 360° approach, it is possible to determine a basic, conceptual framework for personnel planning and development in the company. On this basis, a competence model can be developed that is tailored to the company's needs.

Further training regarding the technologies of the future is not only important for each individual employee but is also an essential key to securing the innovative strength and competitiveness of the German economy. Important research funding programmes are already starting today to secure the employability of employees and thus create the conditions for the necessary leaps in innovation. The research programme "Innovations for the Production of Services and Work of Tomorrow and the Future of Value Creation" of the Federal Ministry of Education and Research (BMBF) aims to find applicable solutions to maintain and expand value creation and jobs in Germany, and to translate scientific research results into applications for business practice. The BMBF's Future of Value Creation programme is also working towards this goal with its funding priorities Working in a Digitalised World, Innovative and Social SMEs, Skills Management in Demographic Change and Industry 4.0. On a legislative level, the draft regulation for AI regulation at European level presented in April 2021 also addresses the opportunities of AI in the area of education/competence development. A possible regulation should be differentiated according to the respective application in this area.

3 Competencies for Artificial Intelligence

A process of competence management and development must be integrated into the strategic orientation of the company. The development of competencies should be in line with the defined corporate goals and interact precisely with the AI transformation of the company. Therefore, strategic considerations must be made at the beginning of competence development: Where is the company headed to? To what extent is the business model evolving now and in the future, and what role does AI play within these considerations? How can AI systems change or improve existing processes and which departments and fields of application are specifically affected by this? Which tasks are new due to the use of AI systems, which are changing, and which may be eliminated? Do these tasks only require the use of AI or should it also be (further) developed? Based on these strategic questions, it is important to examine which AI competencies are available in the company and which AI competencies need to be specifically built up in which areas in order to be able to shape the planned transformation. If it can be estimated which AI competencies are involved, there are in principle various options available for covering this identified need for competencies: Targeted further training of employees in the desired AI competencies or recruitment of external specialists? What are the concrete options for recruiting personnel? Answering these questions, which can only be roughly touched upon here, is an important task of strategic competence management in the context of the AI transformation process in order to successfully shape the AI transformation. In the cyclical process of a management system, the answers to these questions as well as the achievement of the underlying goals must be examined recurrently. Depending on success and failure as well as possibly changing framework conditions, realignments can then be made.

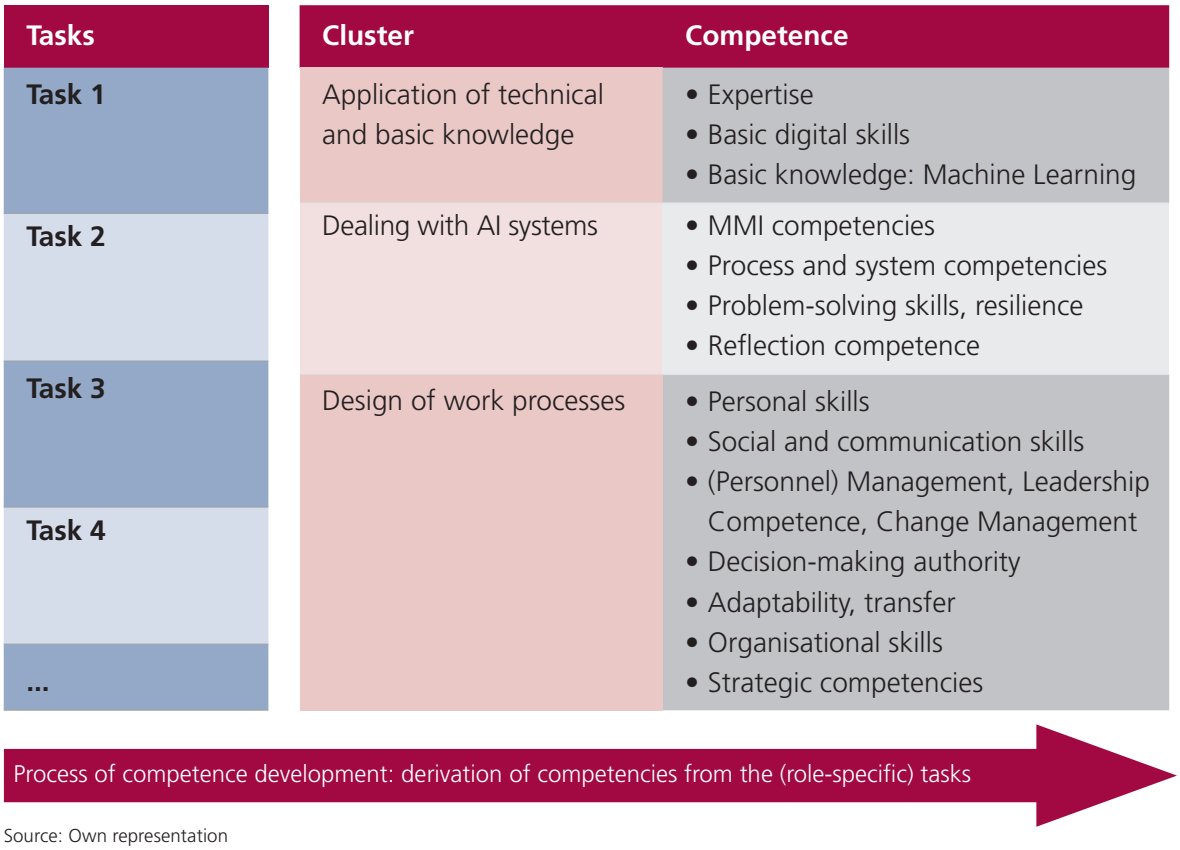
Given this background, it is now the task of competence management for AI to define the specific competencies required for each of the above-mentioned roles (developer, trainer and user) and to initiate suitable internal and external measures for their individual development. This process can be supported by competence-promoting conditions at work (Böhle 2021) and the adaptation of relevant contextual factors (e.g. leadership, organization, corporate culture) (Neuburger 2021).

The prerequisite for this is a clear understanding of the organisational environment in which AI is used and the tasks it is used for, as well as the knowledge, methods and experience that must be applied on a daily basis and in the future in order to be able to successfully and independently manage the multitude of tasks required in each case. The development of competencies for AI cannot be separated from the requirements of digitisation in the professional field, as many of the basic digital competencies also form the basis for the successful use of AI.

In order to describe the requirements, it is therefore necessary to determine contextually how AI affects the accomplishment of the respective task, how the interaction between humans and AI is represented, which roles humans assume and how their responsibilities and activities are defined regarding AI.

The process described below is intended to provide a transparent structure that can be used to figure out what competencies are required to fulfil each of these roles successfully and with a high degree of ownership and professionalism.

Figure 1: Process of competence development and systematisation of AI competencies



Source: Own representation

The competence management process in six steps

The process of competence management can be described in the following 6 steps:

(1) Definition of (job) roles and their responsibilities in the context of AI.

(2) Assignment of tasks in the changed division of work between humans and AI

(3) Derivation and definition of specific AI competencies required for task fulfilment

(4) Definition of competence profiles for each (job) role and definition of the associated target profile

(5) Competence needs analysis: Assignment of employees to the corresponding competence profiles and individual assessment

(6) Definition of suitable further training measures for the targeted AI competence development of employees

Figure 2: Graphical representation of the six steps of a task-oriented competence management process

1. Roles & Responsibilities	2. (Detailed) Tasks	3. Competencies	4. Competence profiles	5. Competence Assessment	6. Advanced training plans
Determination of the technical responsibility along the (core) tasks of an area	a) Definition of (subject)specific (job)roles b) Listing of the (detailed) tasks of each (job) role	Definition and assignment of the competencies required to successfully perform the tasks with a focus on technical skills	a) Definition of a Competence profile for each (job) role b) Determination of the competence profile of the target profile	a) Assignment of the employees to the corresponding profiles b) Individual Assessment for the Target profile	a) Derivation of suitable further training measures for the targeted competence development b) Determination of job role specific curricula

Source: Own representation (cf. Stich 2021).

The realisation of the training and further education measures defined in phase (6) can finally be decisively supported by a competence-promoting design of the organisational and technical environment.

First, there is a need for a basic understanding of the various professional roles (below referred to as (job) roles) in the company organisation. Their description should be prepared by an interdisciplinary team – in cooperation with managers and experts from the specialist departments, with advice from representatives of HR and the works council (see also under Phase 1).

(1) Definition of (job) roles and their responsibilities in the context of AI

In the first step, responsibilities in the respective area and possible interfaces to other areas are described along core tasks using a suitable methodology (e.g. RACI method, see infobox). An important part of this is also the identification of tasks for which this area is not responsible, in order to avoid unnecessary competence requirements leading to overloaded competence profiles. This process requires the best possible experience with the structures and processes in the company in order to ensure a focus on the truly essential responsibilities through critical questioning.

Figure 3: RACI method

RACI method

	Department A	Department B	Department C	Department D	Department E	Department F
Task 1	AR	I			C	
Task 2	R	A	I			C
Task 3	R	A	C		I	
Task 4	A			R	C	
Task 5	C		A	R	I	
Task 6	R		A		C	I
Task 7	A	R		C		I
Task 8	R		I	A	C	
Task 9	AR				I	C

Brief description RACI diagram

In the RACI table, the tasks are listed in rows and the functions/departments involved are listed in columns. In the intersection field of task to function/department, the respective role is entered that links the function/department to this task. There are four types of relationships or roles in the RACI system

- **Responsible** (processor): Who performs the task?
- **Accountable** (Manager): Who makes decisions and takes action for the task?
- **Consulted:** Who is consulted and informed about decisions and tasks?
- **Informed:** Who is informed about decisions and actions?

So in the intersection fields you enter an **R**, **A**, **C** or an **I** or you leave it blank. For each task there should be only one R, i.e. there should not be more than one R per row.

Source: Own representation (cf. allegra, trackplus.com).

(2) Allocation of tasks in the changed division of work between humans and AI

Based on these results, the (job) roles belonging to the area are now defined and these in turn are assigned the respective core and detailed tasks. These process steps can only be carried out with and in the respective areas themselves, as they are based on a deep professional insight into the daily work of the employees.

As a result, a certain number of (job) roles with their associated tasks are now available in tabular form, for example, which form the working basis for the next process step, in which the necessary competencies, in our case AI-related competencies, are assigned to the tasks.

(3) Derivation and definition of specific AI competencies required for task fulfilment

Competencies can be clustered in very different ways: they are often divided into four main groups: professional, methodological, social and personal competencies (Muellerbuchhof 2007; Kauffeld 2006; Erpenbeck, von Rosenstiel et al. 2007; Becker 2008).

A competence is only formed when skills and knowledge ("can"), responsibility ("may") and the motivation ("want") to do something come together (Becker 2008). A competence management system must take these three components into account in order to map the competence requirements in profiles. Competence profiles are derived along the tasks of a (job) role (= may), so that thereby "can" and "want" are mapped, where the "may" is fulfilled by the assignment of the (job) role and its tasks.

Each task is therefore assigned the competencies necessary for successful completion. If a necessary competence has not yet been described, the description must be made individually by experts for this task.

(4) Definition of competence profiles for each (job) role and definition of the associated target profile

Competence profiles are now formed along the tasks described for the respective (job) role. In this step it is particularly important to critically question what the actual task is and to what extent this determines the (job) role. An external view is helpful to determine the relevant competencies of a role and to leave out those that are not relevant. Now, each competence is assigned the expected level of proficiency.

The resulting competence profiles per (job) role each show the target profile that should be achieved for the successful performance of all tasks in this (job) role. Mostly, the representation as a network profile (also called "competence spider") is used for this purpose (see chapter 4).

(5) Competence needs analysis: Assignment of employees to the corresponding competence profiles and individual assessment

In the competence needs analysis, employees are assigned to the corresponding competence profiles and assessed according to their "actual characteristics" along the required competencies. This process step can take place unilaterally, in that the supervisor draws up an individual competence profile of the employee from his or her own observations and then discusses it with him or her in a dialogue. Alternatively, the "actual profile" is designed cooperatively by the supervisor and the employee and then discussed together. The cooperative method, which combines external and self-assessment, is certainly more demanding as a management task, but due to the active involvement of the employees in the process it involves a high degree of motivation, personal responsibility and acceptance of the results.

The required competence is always assessed according to a competence profiling matrix that is valid in the company. In order to prevent a mixture of competence and performance assessment, all participants should be comprehensively introduced to the process of competence profiling. The result of the assessment is the competence needs analysis, which can now be used to define and introduce targeted training measures to close the identified competence gaps.

(6) Determine suitable further training measures for the targeted development of AI competencies of the employees

From the competence gaps identified, suitable further training measures are now assigned or developed. In doing so, it is extremely important to keep the goal of competence development in mind: This means offering both "learning" and "applying", since a competence arises from the independent application of what has been learned to fulfil variable tasks.

Digital learning technologies and offerings enable ever greater flexibility in learning. Informal and formal learning complement each other in the range of further training and enable the targeted training of competencies. The development of competencies has started with the further training measures and can now be evaluated and adjusted in the context of employee appraisals.

The existing job profiles should also be reviewed in regular cycles to ensure that they are up to date and, if necessary, adapted to be able to take account of the requirements in the company arising from innovative technologies such as automation, digitalisation or artificial intelligence at an early stage in the training of skills that will be needed in the future.

Working conditions conducive to learning and supporting competence development

The implementation of the measures for in-company further training defined in phase (6) can be specifically supported and fostered by designing working conditions that are conducive to learning and experience (Böhle 2021). This concerns several levels: the use of suitable technologies, the organisation of the work process and the design of general conditions that go beyond this.

New technologies open up enormous potential for media-based knowledge transfer embedded in work. A concrete example of this is the use of augmented reality (AR) and virtual reality (VR). They make it possible to react to situational competence needs and to promote competencies individually by integrating learning content into everyday work. At the same time, VR and AR enable employees to experience learning content interactively and situationally and to train potentially difficult work processes in realistic scenarios. In combination with artificial intelligence, these scenarios can also be adapted to individual learning levels and progress. The dual function of artificial intelligence becomes clear here. It changes work processes, while the execution of which then requires new competencies. At the same time, it can support the acquisition of these competencies in the long term.

Work that promotes learning and experience is not only, but primarily, about the development of competencies in the process of work – for example in the confrontation with the object of work – through a correspondingly conducive design of work and technology. This includes an organization of work processes that offers opportunities and spaces for action for gaining experience, possibilities for exchanging experience and mutual learning in cooperation (cf. Böhle 2021) as well as an appropriate design of technical interfaces; for example, in human-machine interaction with AI systems (Huchler et al. 2020b; Huchler 2020a).

Finally, companies can specifically promote the process of competence development by creating framework conditions that are conducive to learning. This includes, in particular, management structures that not only enable openness to new developments, learning and gaining experience, but also specifically promote them and provide time for them. This also includes the trust in employees to take responsibility for their own individual competence development and implement the further training plans developed in phase (6) (Münchner Kreis 2020a).

Overview: Competencies for Artificial Intelligence

Competencies relevant to employees and their individual or domain-specific task profiles depend on the respective company and the role assigned to them. Even in the age of AI, employees will not only need to have competencies that are directly related to AI and are exclusively applicable to artificial intelligence or are made necessary by dealing with AI systems. Rather, the digitalisation of many areas of the company is also changing other competencies that often represent a necessary, yet not sufficient, basis for dealing with AI systems.

In addition, the effects that the introduction of an AI system has on the training needs of employees also depend heavily on the specific AI system: Artificial intelligence is – as outlined above – not a homogeneous technology and therefore the implications that arise for employees from the use of AI in detail cannot be generalised. For example, while software that operates a machine by means of gesture control by the human user and relies on AI-based pattern recognition places demands on competencies in the human-machine interaction of employees, employees who have to make strategic decisions based on the recommendations of an AI decision support system will be strongly challenged in their reflective competencies.

Depending on the respective role (programmer, trainer, user), the changing interaction between humans and AI requires different competencies. They can be divided into the following categories (cf. Table 1) and build on non-AI-specific competencies:

- **Technical and basic knowledge,** in order to be able to master the content-related technical requirements of the task on the one hand; on the other hand, also digital requirements as well as new requirements arising through AI, such as machine learning.

- **Dealing with AI systems in order** to be able to understand and shape the changing division of work between humans and technology on the one hand; and to be able to act in this division of work on the other. In addition to typical MMI competencies, this also includes personal meta-competencies in particular. The competent handling of data is central to the development of AI systems, which not only focus on machine learning but also build on knowledge-based systems or mathematical logic (Gesellschaft für Informatik 2019).

- **Designing the context of AI systems to** understand AI as a normal element in daily work and to further develop and manage work and change processes based on it.

Table 1: Competencies for working with and on AI systems

Competence	Description
Technical and basic knowledge	
Expertise	Employees have the necessary subject-specific knowledge / skills to perform everyday tasks appropriate to their position. Depending on the employee's position, this, for example, may also include manual skills.
Basic digital skills	Employees handle conventional digital media and technology safely and confidently and can work smoothly with common office programs and digital collaboration technologies. In particular, they have sufficient awareness of digital security aspects.
AI Awareness	Employees are aware of the AI systems used in the company and their basic capabilities; this includes knowledge of what AI systems cannot do. They are sensitive to the data that the AI system processes, including possible personal data.
Development of the AI systems and handling of the AI systems	
MMI competencies	Employees have competencies for targeted handling in human-machine interaction at the current state of the art.
Basic Knowledge Machine Learning	Employees know and understand the basics of machine learning including deep learning and neural networks and can apply this knowledge in human-machine interaction.
Skills in programming languages, platforms, frameworks and libraries	Employees are proficient in relevant programming languages such as Python as a basis for machine learning. They have a sound understanding of and confident use of common platforms such as Amazon Web Services (AWS) and frameworks/libraries such as Sparks or Hadoop (Büchel, Mertens 2021).
Big Data, Data Science and Data Analytics	Employees have skills in the management, collection, compilation, processing and modelling of data and the analysis of large collections of structured or unstructured data. Important areas of competence include advanced mathematics, cryptography, data ethics and data privacy or data mining (Gesellschaft für Informatik 2019).
Process and system competence	Employees can recognise processes and procedures in the company, think in terms of these processes and procedures and structure their own work behaviour in terms of processes and procedures. They are also able to describe, reconstruct and model these processes and other complex issues as systems and to make forecasts and design options for action on this basis. Specifically, employees realise the specifics of the influence of AI on corporate processes: They understand the changes induced by AI and can optimise their own work processes in relation to collaboration with AI.
Problem-solving skills, resilience	Employees can quickly recognise unexpected situations and difficulties, deal with them and develop suitable solution strategies. This includes the knowledge and, if necessary, the practical ability of how employees can intervene in AI-controlled processes.
Reflection competence	Employees are able to critically interpret and evaluate the information and results of AI systems. They can independently and competently assess when trust in AI systems and the data generated by AI systems is justified.

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Competence	Description
Shaping the context of AI	
Personal skills	Employees have a sufficient degree of personal responsibility and self-organisation. They have the curiosity and willingness to learn and work with machine learning and AI technologies.
Social and communication skills	Employees can contribute to teams with different compositions. They can work together with colleagues from different professional backgrounds and with different levels of experience and competence. In contact with customers and users of AI systems, employees can explain the special features of the use of AI systems appropriately for their respective area of responsibility.
(Personnel) Management, Leadership Competence, Change Management	Employees with management responsibility can organize a team, coordinate and delegate tasks (bundles). They can communicate the potentials and limitations of AI, alleviate fears and activate further training potentials. When integrating AI systems into company processes, they can formulate reasonable goals and thus help shape the change process.
Decision-making authority	Employees know their responsibilities and are able to make reliable, considered decisions within the scope of their responsibilities.
Adaptability, transfer	Employees are able to adapt and adjust their working practices to opportunities and challenges implied by AI.

Source: Own representation.

The Fraunhofer Institute for Industrial Engineering (IAO), together with the University of Augsburg, is investigating how competence requirements will change in concrete terms in the future as a result of the use of AI technologies in a research project commissioned by the working group Future of Work and Human-Machine Interaction. The results, showing what needs companies and employees see in the use of artificial intelligence and what gaps need to be closed through targeted training measures, are to be published shortly in an addendum to this white paper.

The education and training of important key competencies can lay the foundation for the successful introduction of AI systems. This also creates an information base that counters concerns about AI and enables the confident handling of AI technologies.

In accordance with their role in the company, employees must be able to interact competently with AI systems in new work processes. Not all employees will need all the competencies that arise from the different interfaces with AI systems. Some employees will not need to evolve into AI experts for their tasks: For them, on a technical level, an awareness of the potentials and limitations of AI technologies to assess the data basis or a healthy attention to the conclusions of AI systems may be sufficient, while on a social and personal dimension, team skills and self-management will be important. Other employees will have to become drivers of AI change themselves as leaders for employees as motivators and coaches: For them, management and leadership skills will matter a lot. This is especially true if there is a risk that AI will substitute for human activities or jobs or change them very significantly. Finally, there will also be employees who will program, train, support or maintain AI systems on a technical level. These employees will primarily need the necessary technical skills for these tasks, for example in dealing with programming languages or data processing.

These different reference points to the AI competence areas are basically comparable to the handling of conventional digital technologies. An assistant today needs to be competent in using Office programs on the user interface, but a deeper technical understanding of the programs is not required. It will be similar for some roles in relation to AI technologies in the future. Nevertheless, the ability of AI systems to learn also poses a particular challenge for roles not related to the technical aspects of the self-learning systems, since every interaction or input with the AI systems can potentially influence their further development.

The question of the extent to which employees need to acquire a competence can be systematised by differentiating between different competence levels. This classification can be made according to the complexity of the task for which the competence is required as well as according to the degree of autonomy of the task to be performed: The European Commission's digital competence framework, for example, lists eight levels of competence, roughly clustered between basic, intermediate, advanced and specialised competencies (Carretero et al. 2017).

Figure 4: Different competence levels from the European Commission's Digital Competence Framework

Levels in DigComp 1.0	Levels in DigComp 2.1	Complexity of tasks	Autonomy	Cognitive domain
Foundation	1	Simple tasks	With guidance	Remembering
	2	Simple tasks	Autonomy and with guidance where needed	Remembering
Intermediate	3	Well-defined and routine tasks, and straightforward problems	On my own	Understanding
	4	Tasks, and well-defined and non-routine problems	Independent and according to my needs	Understanding
Advanced	5	Different tasks and problems	Guiding others	Applying
	6	Most appropriate tasks	Able to adapt to others in a complex context	Evaluating
Highly specialised	7	Resolve complex problems with limited solutions	Integrate to contribute to the professional practice and to guide others	Creating
		Resolve complex problems with many interacting factors	Propose new ideas and processes to the field	Creating

Source: Own representation (cf. DigComp 2.1).

Low-code AI platforms

Companies are faced with the challenge of competently preparing employees who are directly involved in the development and design of AI systems and who need to build up corresponding competencies in further training for this change at the same time without disillusioning or unsettling them. The anchoring of AI-specific content in training and study curricula will here become an elementary building block of the AI transformation for the specialist workers of tomorrow: However, companies cannot wait for a new generation of AI-competent employees in view of the disruptive nature of AI potential. At the same time, recruiting specially trained data scientists and AI experts can be a major hurdle in the global competition for specialist workers, especially for SMEs (Plattform Lernende Systeme 2021).

An important element for short- and medium-term AI deployment can therefore be no- and low-code platforms, whose offerings are also constantly expanding for AI development and are provided by tech giants such as Google Cloud AutoML or Microsoft Power Apps as well as by smaller companies such as Obviously AI or DataRobot. No- and low-code are tools that can be used to develop machine learning solutions based on simple, visual user interfaces, for example with intuitive drag-and-drop environments. No- and low-code platforms can thus reduce the training requirements for specialists, as they do not have to write codes themselves in the development of AI use cases, thus facilitating access to AI development.

This does not mean that the relevant specialist workers do not need to develop AI-specific competencies. For the use of low-code platforms to make sense for companies, both a deep understanding of the AI methods used and a competent handling of the low-code platforms are necessary prerequisites for employees. This is comparable to common software solutions for technical calculations in mechanical engineering, where the engineer no longer performs the calculation himself, but must have internalized the basic mechanics in order to be able to use the software competently.

Low-code platforms can make a significant contribution to many companies, especially SMEs, on their way into the AI era, as they can often provide solutions for different application scenarios and areas with a variety of prefabricated AI components (Plattform Lernende Systeme 2021). This provides companies with a quick entry into the potential of AI applications, as they can more easily train employees to use the low-code offerings, whereas further training to become AI experts will not be possible. Nevertheless, in the longer term, these solutions cannot replace the development of in-house AI skills: This is because more complex AI solutions cannot be implemented with standardized low-code offerings. Moreover, if core competencies are to be touched and the data treasure of companies is to be lifted by AI, companies could not avoid developing their own AI solutions.

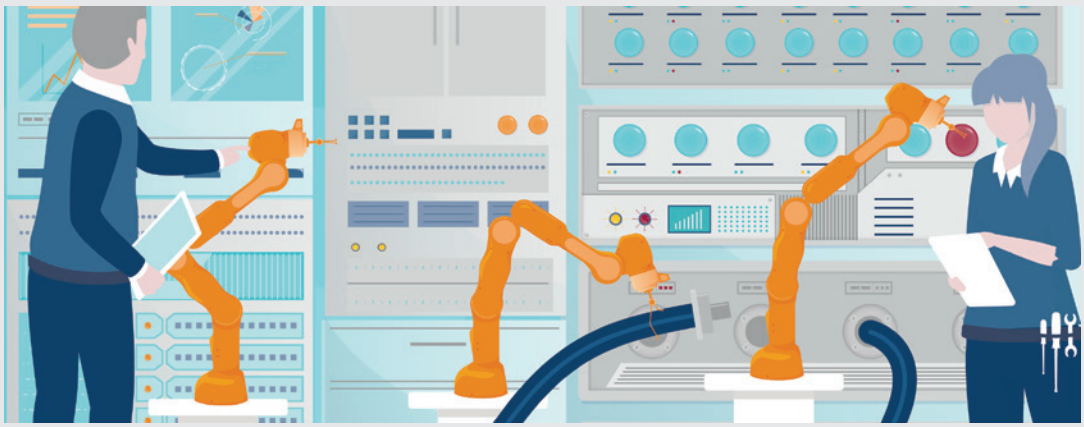
4 Exemplary competence profiles

In the following, the authors analyse three practical examples or role profiles in order to illustrate how competencies must develop further in the AI age for different roles in companies. To this end, the corresponding changes in roles and competencies are first described and then visualized with the help of network diagrams. The network diagrams show both the differences between the various profiles and the dynamic development from the current actual state to a target AI state. The quantification on which the diagrams are based does not claim to be empirically correct but is merely intended to serve as an illustration based on the authors' assessment.

The practical examples should describe different responsibilities and work areas along the organizational value-added structure in a fictitious company in order to obtain a meaningful cross-section of the diversity of the working world. The selected areas are finance and controlling as well as production. The role profiles are largely taken from the production environment and are based on the application scenario "Learning Robot Tools", which was developed by the working group Future of Work and Human-Machine Interaction of Plattform Lernende Systeme. For this white paper, the authors develop the setting of the scenario further and bring together different task areas and roles under one company structure. The profiles are intended to illustrate individual employees as concrete individuals of a diverse workforce, which is why a contingent gender of the employee was chosen as an example for each profile.

Application scenario Learning Robot Tools

A medium-sized company is active in the production of cable harnesses for the automotive industry. Depending on customer requirements, different cable runs, and cable lengths have to be assembled with high precision. In the future, intelligent robotic tools will support the specialist workers during assembly. For this purpose, the tools adapt flexibly to the varying work steps.



Today, manufacturing companies are already using robotic systems that relieve workers from assembly line tasks through automation. In the future, humans will guide AI-supported robots in production:

In doing so, the intelligent tools will be able to learn new skills depending on current needs, thus enabling more flexible automation.

The tools will work reliably hand in hand and safely with the employees - wherever they are needed. To this end, they will adapt to the employees and the respective work environment. Learning robot tools will also be able to react to their own working methods and special routines. Through the direct collaboration of humans and learning tools, explicit programming, and independent learning of the AI systems merge.

Potentials of AI technologies are often seen and discussed in the public perception in production. However, AI systems can also take over more and more tasks in the classic office activities of clerical work. Clerical tasks are tasks with predominantly structured and thus standardizable processes from different functional areas. The most common form of clerical work is office work with a high proportion of routine activities, but it can also include tasks in assistance or management.

The main tasks in the areas of analysis and verification of facts and processes are characteristic of clerical work. AI systems can provide support here by automating (business) processes, gaining knowledge through data analysis, but also through interaction with customers (Behrens et al. 2021).

Example 1: Industrial forewoman

The industrial forewoman is an industrial-technical manager and acts as an interface between the management and manufacturing levels. The use of adaptive robotic tools has a direct impact on her area of responsibility:

Technological innovations such as the use of robotic tools lead to a change in production processes as well as in the demands on the workforce and therefore require increased **adaptability**. Thus, in addition to learning new skills and knowledge, one's own working methods and the entire internal team organization must be adapted to the use of self-learning systems. The forewoman also ensures the goal-oriented use of the robotic tools in the production system.

With her technical and organisational knowledge, the forewoman is responsible for the smooth flow of production and operationally ensures occupational safety and the quality of the products. The integration of self-learning systems such as robotic tools increases the demands on their **professional competence**. This includes ensuring that the specialist workers handle the robotic tools properly so that the required quality standards are met and potential hazards due to incorrect handling are minimized.

In order to identify and eliminate potential hazards to the workforce from robotic tools, suitable measures for occupational safety and accident prevention must be derived and implemented. **Expertise in human-machine** interaction is essential for this. It is not primarily the forewoman who work with the robotic tools but the specialist workers. However, as the direct supervisor, she must be familiar with the working methods and collaboration forms of the robotic tools in order to instruct the specialist workers under her command and to have an overview of the individual processes in her area.

The training and programming of the robot tools is carried out at the production level by the specialist workers. In order to train them and provide them with basic knowledge and the knowledge required to program the specific robot tools, the forewoman now also needs **basic knowledge about machine learning**, particularly with regard to the handling and use of self-learning systems. As the contact person for questions and problems that arise, she provides assistance or intervenes to correct problems and must therefore not only understand the characteristics of machine learning, but must also be able to communicate them.

The use of the adaptive robot tools allows the company to flexibly accept small orders with low quantities. This may make it necessary to adjust the functionalities of the robotic tools, which no longer result from training by hand, but from adaptation to the basic AI programs. In case of doubt, far-reaching adaptations must be carried out by the manufacturer's AI experts if, for example, a medium-sized company cannot build up the necessary skills internally. However, the forewoman herself can configure smaller programs herself via low-code systems, for which she must acquire the corresponding competencies.

In addition to occupational health and safety and quality assurance, the forewoman must ensure that all equipment functions smoothly. The use of self-learning systems in production increases complexity and the workforce is confronted with new problems that differ from those in conventional production. In order to be able to quickly take corrective action when problems occur with the robot tools, the existing **problem-solving competence** must be expanded to include the problems of the self-learning systems. If employees notice a malfunction that they cannot solve on their own, the forewoman is often the first contact person. However, she can only resolve malfunctions to a certain extent. This is because the industrial forewoman is not an AI expert: Training and use of the learning systems can be carried out and taught by her, but in the case of program errors she must rely on the expertise of the AI developers.In the case of malfunctions that she cannot resolve on her own because their solution requires a deep understanding of machine learning that goes beyond the application level, she should still be able to understand and analyse them to a certain extent. This ensures that she can directly contact the right person so that the malfunction can be corrected as quickly as possible.

In such cases, for example, communication with IT specialists or the developers of the robot tools is necessary. Thus, the interface position, in which the forewoman communicates both with the management level above her and with the specialist workers who re-

port to her, is expanded to include other areas. This interdisciplinary exchange requires greater **communication competence in order** to ensure that coordination is goal-oriented across departments and also across companies, and in order to break down possible communication barriers that may arise due to different technical backgrounds.

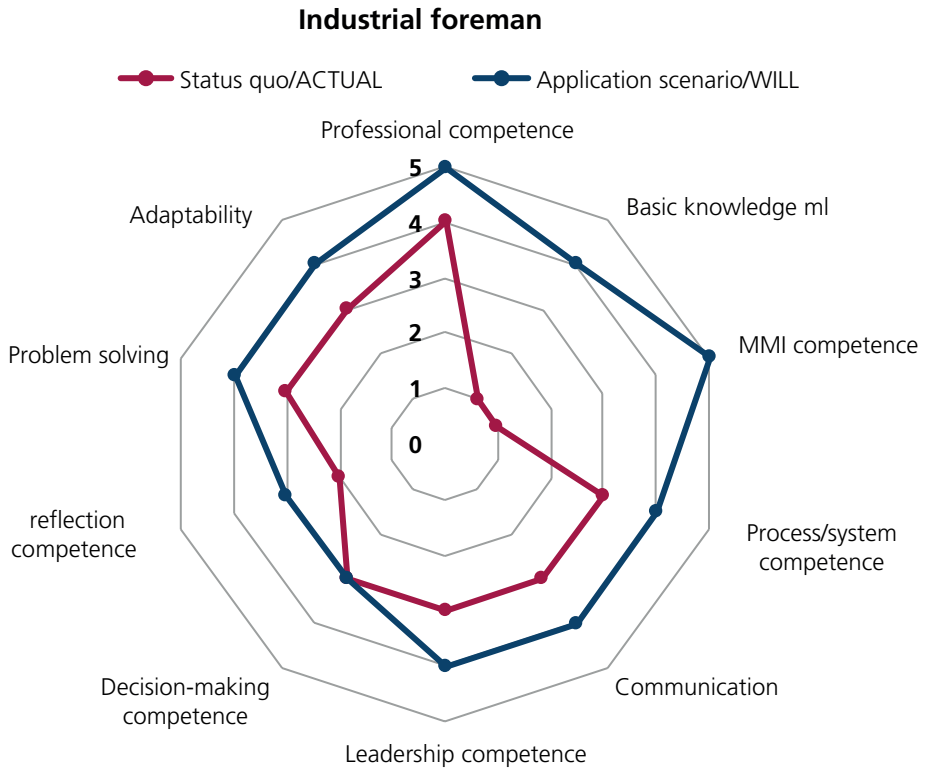
Not only communication with other areas is changing, but also with the subordinate specialist workers. This has an impact on the demands on the leadership competence of the forewoman. As a direct supervisor and contact person, she is responsible for the professional concerns and problems of her team. In order to dispel these with regard to self-learning systems and to ensure their acceptance, it is the task of the forewoman to communicate the potential and benefits of the robotic tools as well as to create a motivating working atmosphere. Furthermore, she assesses the skills and knowledge of the specialist workers, which she now also has to assess with regard to the self-learning systems. Based on this, the forewoman assigns the specialist workers their respective tasks and participates in the development of individual further training and qualification plans. Through further training, fears and concerns about the new technology can be reduced and at the same time the shortage of specialist workers can be counteracted. The industrial forewoman is also involved in change management. On the one hand, she is significantly involved in the implementation of changes at the production level, such as the integration of robotic tools, and on the other hand, she can identify and initiate possible improvement potential and measures due to her direct work with the robotic tools.

The industrial forewoman has an overview of the processes running at production level and monitors compliance with the work plans. Processes that were previously carried out successively can now run in parallel thanks to the use of robotic tools. In addition, products are becoming increasingly individualized. This makes production processes more flexible, but also more complex, which requires greater **system and process expertise**. In addition, it is necessary to analyse and interpret the collected data and information of the self-learning systems and also of the supporting digital systems in order to subsequently incorporate them as a basis for decision-making or as a basis for improvement measures.

Due to the complex and flexible production processes, the forewoman is faced with new **decision-making** tasks, which she makes reliably and well-considered through her **decision-making competence** within the scope of her responsibility. For example, the specialist workers want to make sure when a robot tool has been sufficiently trained and can now be actively used in the production process. Decisions that go beyond their authority must continue to be left to their superordinate body, such as production management, but they can contribute suggestions and ideas.

The competence to **reflect** is already important in many aspects. In addition to reflecting on her own work and that of her department, the forewoman must now also be able to assess the use of the robot tools. Based on this, possible potential for improvement can be identified and developed. She must also be able to assess the relationship and task allocation between the use of robotic tools and that of specialist workers in the best possible and goal-oriented manner.

Figure 5: Possible change in competencies for the industrial forewoman



Source: Own representation. Note on the presentation: The importance of the respective competencies is divided into five levels according to their relevance for the respective activity and role profile. The qualification does not claim to be empirical. correctness, but is intended only as a visual illustration and as a basis for discussion. The guiding question is what competence needs will be specifically added by the use of AI in companies, which competencies will gain in importance and which lose their current relevance.

Legend for quantification: 1: The competence has no or only negligible significance for the job profile. 2: The competence is not essential for the job, but helpful. 3: The competence can be taken for granted and is essential for many tasks of everyday work are important. 4: Competence is of paramount importance for most central tasks. 5: Competence occupies a key position and cannot be substituted.

Example 2: Specialist worker

The specialist worker is affected by the use of the new technology in his work processes with concrete effects on his competence profile. When working directly with robotic tools and the AI systems on which they are based, the following competencies are of particular importance:

Today, given the application scenario example, the specialist worker must know how to correctly lay and assemble the individual cables of a wiring harness, and he needs manual skills to lay the cables. In the future, part of the required **skill** set will be to train and operate the robotic tools by guiding them by hand. This will include knowledge of proper behaviours for safe interaction with the robotic tools. The importance of one's own manual skills will slightly decrease. Using the robotic tools will also mean working on multiple projects: For example, the specialist worker will first show a robotic tool the steps of a project, which the tool can then perform itself for a defined number of workpieces. After that, the specialist worker can turn his attention to a second project, working hand

in hand with another robotic tool on a wire harness that the specialist worker would not be able to process on his own. Multi-machine operation becomes an essential part of the specialist worker's expertise, which is slightly increasing in importance overall.

From time to time, the specialist worker must check the work progress of his individual projects and intervene if necessary. He must also know at which point in time which of the projects needs attention and when the robot tools can work independently. Adhering to structured **work processes** will take on greater importance for the specialist worker; a competence that he already needs today, however.

In order to program and collaborate with the robotic tools, the specialist worker needs a **basic knowledge of machine learning**. This is particularly important in practical terms, as the specialist worker must demonstrate the task to be learned in consistent steps, as ambiguous input will guide the system to behave incorrectly. In addition, it is important to think about the interconnectedness between systems. The ML skills of the specialist worker are very practice-oriented: While he needs to understand how his behaviour affects the tools, he does not need to understand the deeper technical level of the self-learning systems in the robot tools for a competent daily work routine.

Robotic tools are becoming a constant companion in the everyday work of the specialist worker. This daily routine cannot be mastered without competencies at the **human-technology interface**. The specialist worker will learn with the robotic tools, for instance to demonstrate the individual work steps to them, critically accompany the process of learning and, if necessary, intervene to correct it, monitor the independent work of the tools, recalibrate faulty robotic tools and collaborate with the robotic tools on some tasks. Especially for collaboration, occupational safety is a central requirement.

Consequences of robotic tools for the specialist worker include being used in different task areas at shorter intervals than before. The specialist worker must be able to adapt quickly to this and to the new capabilities of the self-learning robot tools; his **adaptability** will be in much greater demand. Working with robotic tools as self-learning systems will also require them to adapt their own working methods to the learning behaviour. For example, if the system can learn better if the individual work steps in the learning process each take approximately the same amount of time, it may be required to focus much more on consistent work step times for the sake of learning progress and productivity.

Due to the use of robotic tools, the specialist worker will be involved in different contexts in the future, which will require an increased level of **communication skills** with colleagues from other areas or projects as well as with managers. The specialist worker must be able to communicate problems, challenges and solutions across disciplinary boundaries - both with regard to the assembly of the cable harnesses (e.g. agreements with col-

leagues or the production manager) and with regard to the handling of the robotic tool (e.g. problem solving).

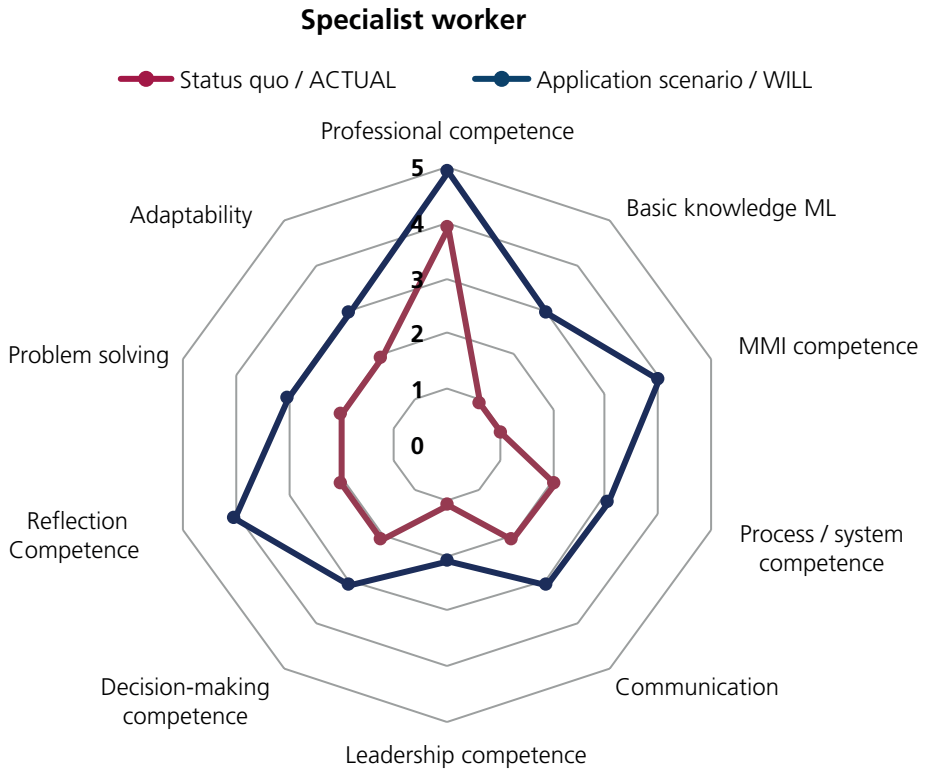
The same applies to the **leadership skills of** the specialist worker. The more flexible design of the production process can lead to teams being repeatedly rearranged and to individual specialist workers taking over certain leadership responsibility as well – both during the transformation phase and afterwards.

Outside his direct field of work, the specialist worker is not responsible for decisions today. His **decision-making competence** could gain in importance through the use of robotic tools if his area of responsibility becomes more individual. For example, the specialist worker will have to decide when a robotic tool has learned enough to perform a task independently. He will also have to be able to make trade-offs – for example, between quality assurance and the start of a new project. However, he will usually not make these decisions alone, but within the existing organizational framework.

The **reflection competence** of the specialist worker is important for such decisions. He must be able to perceive and evaluate the learning and work steps of the robot tool against the background of his technical competencies and his knowledge of machine learning and draw conclusions for his own working methods. In addition, reflection competence is important in order to be able to correctly assess the "learning state" of the robot tool or possible malfunctions. This attention is especially necessary at the beginning of the introduction of self-learning systems. Later, the specialist worker will also develop automatisms for the right moment in dealing with AI systems through daily cooperation.

A more flexible work environment also means potentially more situations with problem character. Even if the specialist worker does not have to make the decisions in all cases, his **problem-solving competence** nevertheless becomes considerably more important. For example, in the first instance he may be confronted with problems such as varying malfunctions, each requiring different approaches to a solution. However, the specialist worker will not be confronted with fixing malfunctions himself: First, he can turn to (direct) superiors with problems that are unsolvable for him; recalibration of the tools ultimately belongs to the scope of internal or external AI experts. Part of the problem-solving competence of the specialist worker is the opportunity to become even more involved in innovation processes in the company than before - for example, with suggestions for improving processes or the best possible use of the robotic tools

Figure 6: Possible change in competencies for specialist workers



Source: Own representation. Note on the presentation: The importance of the respective competencies is divided into five levels according to their relevance for the respective activity and role profile. The qualification does not claim to be empirical. correctness, but is intended merely as an illustration and as a basis for discussion. The guiding question is what competence needs will be specifically added by the use of AI in companies, which competencies will gain in importance, and which are losing their relevance today.

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Example 3: Employee Finance/Controlling

The employee in Controlling is responsible for managing the company's budget and communicates important findings to the company's management, including strategic market analyses. The use of AI technologies also means significant changes in the company's controlling department:

The importance of the **expertise of** the employee in Controlling will decline due to the use of AI technologies in her department. This is because AI systems can unleash their potential in both operational controlling, i.e. budget management, and strategic controlling, i.e. market and demand analysis. For example, AI systems will help make strategic product decisions with predictive models based on market data. Since AI systems can recognize patterns and thus identify irregularities, they are already being used, for example, in the auditing of annual financial statements. The time thus saved can be used by the employee for strategic controlling tasks and thus support the company management even more.

In the future, the requirements for digital competencies will expand to include Big Data competencies and competencies in **human-machine interaction**. The employee in Controlling must work with different AI systems in her field of work on a daily basis and be able to use them independently and competently. Among other things, understanding of database structures or knowledge in statistical procedures may be necessary as part of professional competence forming a basis for competent human-machine interaction.

Today, **basic digital skills are** among the most important competencies in the field of finance/controlling: The use of office programs, especially spreadsheet tools (e.g. Excel), is essential for today's job profile of the employee in Controlling. The requirement for this will decline, as the AI systems used in controlling can be used particularly effectively here. The requirements will not disappear completely, however, as the employee in Controlling may have to become active herself for quickly required analyses, for example.

This example already shows that the daily work of the employee in Controlling will change - and she will have to adapt to the new technologies. **Adaptability** will become a key competence for the controlling employee not only in the transition phase to the AI systems, but also in the long term: Since the systems can evolve independently, the controlling employee must also be able to adapt to new functions and behaviours.

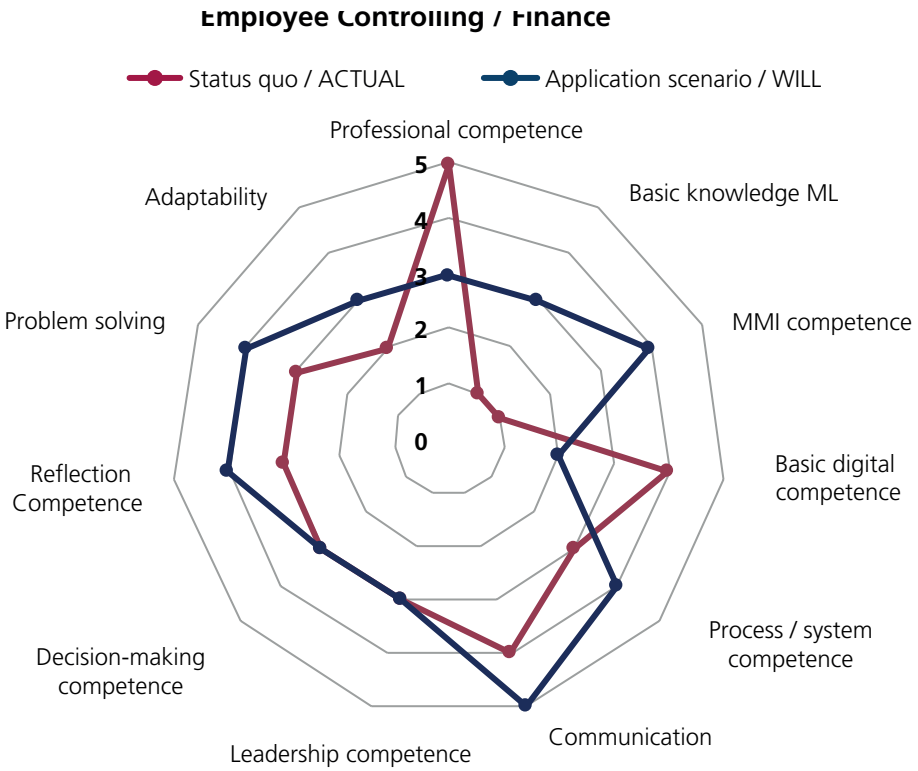
The controlling employee supports the company management in planning and controlling business projects. In order to accompany these strategic decisions, she should have a distinctive **process competence** and link processes, personnel and corporate goals in a coordinating manner. AI systems make this ability all the more important as corporate processes and strategic decisions become more fast-moving and complex.

For the training of the AI systems as well as in the operational use, the controlling employee must obtain data and key figures from the individual departments of the company as a working basis for the self-learning systems. Her **communication skills** will be just as important in the future as they are today. This is especially true when she has to work together with different departments on an interdisciplinary basis.

The controlling employee must communicate the results of analyses to the company management so that directional decisions can be made there on the basis of these results. AI systems will be able to support her in the preparation of presentations when making predictions and preparing data. The decision as to which results she presents to the company management and which decision options she favours must be made by the controlling employee herself on the basis of **her reflective and decision-making competencies**.

Social skills are just as important for the controlling employee as **problem-solving skills** when it comes to strategic decisions about the company's future that have concrete effects on the employees; for example, when AI automation creates training requirements or when tasks shift. Controlling employees are already confronted with these conflict situations today, and the disruptive nature of AI technologies means that such situations will probably affect the controlling employee more frequently.

Figure 7: Possible change of competencies for the employee Controlling/Finance



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5 Outlook

Self-learning systems will have an impact on the task and role profiles of employees. Early qualification and competence development as further training in the sense of lifelong learning and work-integrated learning are an important basis for enabling companies and their employees for the AI era (Rampersad 2020). The development of competencies for AI technologies should be understood as a national task that requires efforts from companies, employees, employee representatives and politics.

After all, developing skills in artificial intelligence and understanding digitisation in general is first and foremost a social task that affects everyone in the population. The broader the public's understanding of AI becomes, i.e. the better potential employees are familiar with the basic systems and working methods of an AI system, the easier it will be for companies to find suitable qualified employees - and for employees to meet the new competence requirements. A fundamental understanding of AI in all sections of the population also opens up the possibility of an open and fact-based social discourse on AI technology and thus also creates the basis for acceptance of and trust in AI systems. This is also shown by the current results of an expert survey (Münchner Kreis 2020b).

At the beginning of an AI competence process, the identification of qualification and competence needs must be the starting point for targeted training and further education measures in companies as well as in educational institutions (cf. Stowasser & Suchy et al. 2020). This concerns both general competencies in dealing with AI technologies and specific company competencies. Companies must therefore first develop an understanding of what the use of AI systems means for their business models. The identification of important areas of competence should take place in close consultation with the employees.

However, identifying AI competencies is only the first step for companies and managers to make their employees fit for the use of AI technologies. While the employees of tomorrow will be taught important digital and AI skills in school and university or company training, it will be a challenge for many employees to acquire the new technologies in tandem with their tasks in the company.

When it comes to skills development, companies are not alone: Building AI skills as a basis for confident handling of AI technologies is a huge task that requires all relevant stakeholders to work hand in hand. Companies should be able to rely on the support of public institutions for the qualification of their employees. Offers from public educational institutions such as the digital learning factories can be further developed for qualification with AI competencies. The "Regional Competence Centres of Labour Research - AI" are being established by the BMBF as the central points of contact in science in order to gear research specifically to the challenges in regional working environments and to support transfer to company practice and the breadth of society. Competence development in the context of AI plays an important role in the first "Regional Competence Centres of Labour Research", AI in the Working World of Industrial SMEs in OstWestfalenLippe (KIAM) and

the Competence Centre for Work and Artificial Intelligence in the Rhine-Main Region (KompAKI), AI for Work and Learning in the Karlsruhe Region (KARL) and Transfer Hub of the Ruhr Metropolis for Human-Centred Work with AI (HUMAINE).

The AI and SME 4.0 competence centres are also already making an important contribution to competence development in companies. With the Future Centres of the Federal Ministry of Labour and Social Affairs (BMAS) and the further training networks adopted and funded in the National Further Training Strategy jointly supported by the Federal Government, the states and the social partners, SMEs in particular are supported in implementing the digital transformation and AI further training (cf. National Further Training Strategy).

However, there is often a lack of clarity and quality assurance of the various continuing education offerings, not only for continuing education in the field of AI, but also for employees, managers and HR managers in companies (Pothmer et al. 2019): The National Continuing Education Strategy therefore describes transparency of education offerings as a central goal, which is being addressed with the innovation competition "Digital Platform for Continuing Vocational Education and Training", among other things. The aim of this competition is to establish interactive learning platform structures in order to enable and offer tailored continuing education and training courses (cf. National Continuing Education Strategy).

In order for employees to be able to accept corresponding further training measures on AI technologies in the best possible way, companies should establish a further training culture of openness and transparency: Based on the idea of lifelong learning, opportunities for individual further development of employees through and with the cooperation with AI systems should be emphasized and, at the same time, concerns should be dealt with honestly. Employees, in turn, must be willing to embrace the new technologies and the associated further training and to accept the changes – both personally and in the company.

Regardless of the specific tasks and competence requirements of an employee, the use of AI technologies will require a certain degree of problem awareness for the peculiarities of self-learning systems. Especially if employees are not or will not become AI experts, i.e. AI systems can easily become black boxes, attentive handling of self-learning systems is necessary in order to exploit the potential of AI systems and at the same time minimise risk factors, for example by recognising incorrect patterns based on faulty training data and not implementing potentially harmful recommendations. Questioning recommendations and decisions of AI systems and checking them oneself is not only based on the necessary awareness of the employees for AI, but also on a lived positive error culture that encourages the employees to think and act independently and critically towards AI. Establishing this culture is the task of managers – an AI management culture becomes a success factor for the introduction of self-learning systems. Following on from this, the working group Future of Work and Human-Machine Interaction therefore intends to devote its next paper to the challenges of AI for leadership.

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About this white paper

This paper was written by the working group Future of Work and Human-Machine Interaction of Plattform Lernende Systeme. As one of a total of seven working groups, it examines the potentials and challenges arising from the use of artificial intelligence in the world of work and life. The focus is on questions of transformation and the development of humane working conditions. In addition, it is looking at the requirements and options for qualification and lifelong learning as well as starting points for the design of human-machine interaction and the division of work between humans and technology.

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About Plattform Lernende Systeme

Shaping self-learning systems for the benefit of society – with this claim, Plattform Lernende Systeme was initiated in 2017 by the German Federal Ministry of Education and Research (BMBF) upon proposal of the Expert Forum Autonomous Systems of the Hightech Forum and acatech – Deutsche Akademie der Technikwissenschaften. The platform pools existing expertise in the field of artificial intelligence and supports Germany's further path to becoming a leading international technology provider. The platform's approximately 200 members are organized in working groups and a steering committee. They demonstrate the personal, social and economic benefits of self-learning systems and identify challenges and design options.

Imprint

Editor
Lernende Systeme –
Die Plattform für Künstliche Intelligenz
Geschäftsstelle | c/o acatech
Karolinenplatz 4 | 80333 Munich
www.plattform-lernende-systeme.de

Design and Production
PRpetuum GmbH, Munich

Status
September 2021

Image credit
Gorodenkoff/Adobe Stock/title

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Recommended citation
Elisabeth André & Wilhelm Bauer et al. (Hrsg.): Competence development for AI – Changes, needs and options for action. White paper from Plattform Lernende Systeme, Munich.
DOI: https://doi.org/10.48669/pls_2021-2