Lernende Systeme

GERMANY'S PLATFORM FOR ARTIFICIAL INTELLIGENCE

PROJECT REPORT

AI competence development in office and production work

Menschzentrierte Künstliche Intelligenz
Institut für Informatik

Universität Stuttgart
Institut für Arbeitswissenschaft und Technologiemanagement IAT

Universität Augsburg
Fakultät für Angewandte Informatik

Fraunhofer IAO

SPONSORED BY THE

Federal Ministry of Education and Research

acatech
NATIONAL ACADEMY OF SCIENCE AND ENGINEERING

WHITE PAPER

Elisabeth André and Wilhelm Bauer et al.
AG Work/Qualification and Human-Machine-Interaction

Table of Content

Summary

The introduction of artificial intelligence (AI) in companies changes the task and role profiles of employees. AI competencies are required in all company domains and for different tasks. In the white paper Kompetenzentwicklung für Künstliche Intelligenz – Veränderungen, Bedarfe und Handlungsoptionen the working group Future of Work and Human-Machine Interaction of the Plattform Lernende Systeme published an overview of competence needs and task-oriented competence development for the AI era. (André & Bauer et al. 2021).

This paper presents complementary findings from a micro-study. The objective of the micro-study was to gain data from business practice in order to complement the elaborations of the white paper with empirical findings. By means of an online survey that addressed company specialists and managers (N = 50), requirements for AI-specific competencies and company offerings for AI qualification were elicited, among other AI related topics. The survey was based on an extensive literature research, from which distinguished application scenarios for AI-supported office and production work were derived; they formed a subject-specific starting point for the survey. The results of the online survey were commented on by a panel of experts during a public webinar of the Plattform Lernende Systeme in Fall 2021.[1]

The survey results show that the topic of AI is currently being discussed primarily at strategic company level and in the context of pilot applications. The respondents' understanding of AI is oriented toward the technical state of the art and suggests a pragmatic view. Accordingly, AI applications should primarily contribute to increases in operational productivity and flexibility in order to better meet customer needs and improve profitability. Although a technical-functional view dominates, a number of human-centered aspects come into play that are considered critical to the success of AI deployment:

- Competencies are to be understood as elements of change management. In addition to innovative ideas, the change management also requires social-communicative competencies and the develpoment of ethical values.

- Successful implementation of AI applications requires both information technology skills and domain-specific expertise. Employees with both areas of expertise are rarely available.

- The experts predict a shortage in the availability of qualified employees. There are only a limited number of employees with specialist qualifications who can be recruited on the job markets. As a result, particularly small companies are relying on in-house qualification of employees in the field of AI.

1 More information about the event can be found here.

- There is a particular need for further qualification for specialists and executives. The prioritized age group for training is 30 to 39 years. However, AI competencies are not so much age-dependent as they are shaped by the interests of the individual.

- Low-skilled and temporary workers are rarely included in AI training programs. Appropriate qualification offerings must also be created for this employee group, for example to ensure the reliability of business processes or to foster employability.

- AI-specific qualification programs are preferably carried out as "on-the-job training" or "in-house seminars" in order to strengthen the relevance to business applications. Such forms of qualification open up innovative potential for multimedia forms of knowledge transfer. Experience-oriented on-site events complement these digital formats.

A selection of recommendations for action based on the survey results can be found in the white paper. mentioned at the beginning of this article. They concretize ways and means for the competence development of clerical and production work.

1. Introduction

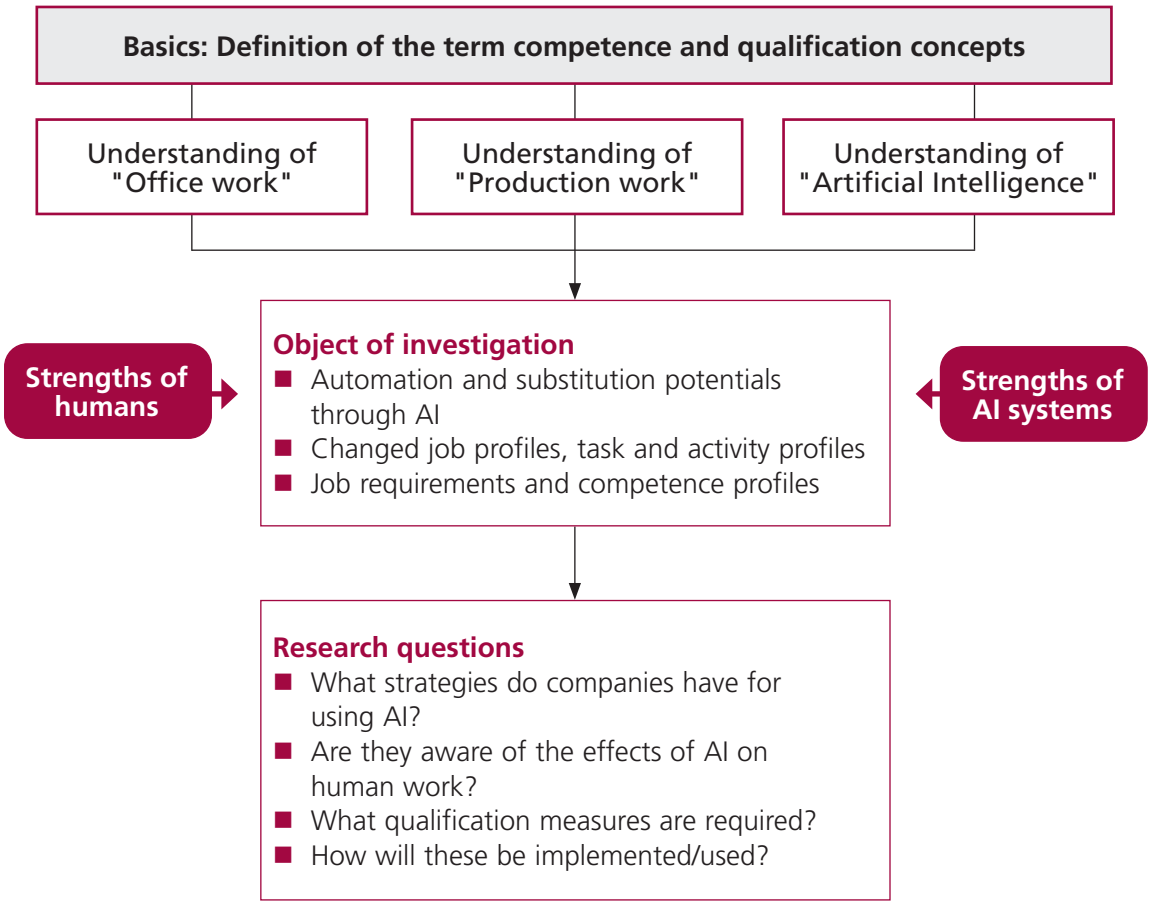
The "Micro Study on Competence Requirements for AI Applications in Office and Production Work" complements the activities of the working group Future of Work and Human-Machine Interaction of the Plattform Lernende Systeme. These are documented in the white paper „Kompetenzentwicklung für Künstliche Intelligenz. Veränderungen, Bedarfe und Handlungsoptionen" (André & Bauer et al. 2021).

The study aims to contribute applied research findings to the ongoing discussion about the extended competence requirements for the use of AI. At a later point in time, concrete measures for the development of competencies in office work and production work could be derived from this.

The project goal was achieved with the following approach:

- Literature review: Elaboration of the essential work regarding artificial intelligence, office work and production work, the changing job profiles due to the use of AI, and qualification measures
- Development of ideal-typical job scenarios for AI-supported office work and production work and derivation of job profiles for digitized work
- Identification of qualification and competence requirements, and qualification paths of these job profiles
- Realization of an online survey for company decision-makers (e.g., executives, IT experts) to determine the relevance of the theoretical qualification requirements and the outlined qualification paths.
- Presentation and discussion of the survey results by selected experts in a webinar on September 29, 2021.

Figure 1: Schematic representation of the project-related work steps



An integral part of AI systems is the ability to make decisions. Thus, AI systems enable a mutual human-technology interaction instead of a humans' one-sided use of technology. Human thinking is based on the abilities of a reflective understanding, problem awareness, insight, and decision leading judgment (or weighing). The functioning of a computer, on the other hand, is based on technical functionality, which is based on more or less complex algorithms.

Currently, using machine algorithms, it is not possible to model human reasoning that bases beliefs, decisions, and attitudes, and that develops a coherent worldview and practice of action on that basis (Lenzen 2019). Moreover, the attempt to replicate these real-world reasonings with the help of machine algorithms leads to two fundamental problems:

- The complete and adequate formal transformation of human decisions, taking into account a wide range of factors, to technical systems is not possible.
- Machine learning methods that attempt to represent even a part of the real-world lead to an enormous increase in complexity.

2. The Change of Work

2.1 Work types

Given the increased potential for automation through the use of AI, it can generally be assumed that purely routine activities will decline proportionately, while situational task requirements will gain in importance (Apt et al. 2016; André & Bauer et al. 2021). Whether and how these changes will take place in concrete terms is currently largely an open question. Some studies address the optimistic perspectives that anticipate job gains, rising demands on work, and a general upgrading of activities and qualifications. Other trend studies take a more skeptical view of the development and point to risks such as job losses, de-skilling tendencies and social uncertainty (c.f. Braun 2017).

It is also unclear in which direction the qualification requirements associated with the task structures will develop. The deviating development perspectives are typically described as "upgrading of qualifications" and "substitution of human labor" (c.f. Table 1). The upgrading of qualifications describes a human-centric approach. It is based on the assumption that digitization will make work processes more demanding, interconnected and complex (Spath et al. 2013). The substitution of human labor emphasizes a technology-centered design approach. The core of the substitution thesis is that a gap is opening up between complex activities with high skill requirements on the one hand and simple activities with low skill levels on the other, and that middle skill groups are losing importance.

Table 1: Scenarios for forms of work in view of digitalization

Type of work	Upgrading of qualifications: Human-centered work	Substitution of human: machine-centered work
Work in dynamic conditions	Skilled and knowledge work	Process support
Routine work	Semi-skilled work (also interaction work)	Full automation (incl. residual tasks)

2.2 Work activities

Routine, manual and abstract work

Work activities can be assigned to routine, manual and abstract activities (Arntz et al. 2016). Routine activities primarily involve clearly defined, repetitive tasks. Manual work include situational adaptations, based on verbal and visual recognition, on the one hand, and interpersonal interaction, on the other. Abstract work require problem-solving skills, creativity, intuition and persuasive skills (c.f. Table 2).

The increased use of digital technologies is superseding routine activities across all industries, especially when these are carried out on the basis of standardized, structured data and when unambiguous information is provided. Examples of this are the treatment of forms or the monitoring of technical processes. This automation tendency can now be seen in jobs with simple, medium and high task complexity and the resulting demands on the workforce's qualifications. It is to be expected that this tendency will also increasingly affect activities in which less structured data and more volatile layers of data are processed.

Table 2: Classification of work

Routine work	Manual work	Abstract work
■ Measuring, testing, quality control ■ Paperwork, correspondence, forms management ■ Calculating, accounting, booking ■ Monitoring or controlling machines, systems and processes ■ Physical or manual work for the production of goods ■ Transporting, storing, shipping	■ Repair, maintain, restore ■ Catering, serve, or accommodate ■ Care, assist, or heal ■ Clean, remove waste, or recycle ■ Securing, protecting, or guarding	■ Collect information, research, documentation ■ Organizing, planning, preparing work processes ■ Developing, researching, constructing ■ Programming, data processing ■ Apply or interpret regulations ■ Train, teach, educate ■ Advising and informing ■ Buying and selling ■ Advertising, marketing, public relations ■ Hiring personnel, Instructing, controlling, evaluating employees ■ Negotiating

Source: Own representation (cf. Arntz et al. 2016)

Office work and production work

Office work is mostly management or administrative work. Typically, office work involves a specific area of work, outlined in a job description, which is performed independently within the scope of delegated competencies and responsibilities. The activities performed are knowledge-based and require extensive specialist knowledge and predominantly autonomous labor. Processing is carried out with the help of job specific tools and expertise on the basis of more or less detailed work instructions. A work or administrative process is processed until it is ready for a decision and then completed until it is implemented as a market-ready product, service, or administrative act.

Production work serves the production of industrial goods. These goods can include material goods, energy, and services. In this context, the terms production, manufacturing and fabrication are often used synonymously. Production work is the instrumentally bound, purposeful, socially useful planned activity for which mental and physical resources are used in production and service.

Both office and production work, as defined in this study, are carried out with a target-oriented scope on the basis of detailed work instructions. Activities are characterized by a relatively high degree of repetition. Both fields of activity will change due to the digitization of work resources (Bartscher/Nissen 2017).

2.3 Digitization of office and production work

Arntz et al. (2016) classify the degree of automation and digitization in office and production work by means of three levels: For production resources, the distinction ranges from manually controlled work resources to self-controlling machines and systems. The former still involve a high degree of human intervention, while the latter primarily involve the automatic processing of work processes by technology. The information and communication tools used in office work are classified accordingly. These range from non-IT-supported tools, such as the telephone or telefax, where humans are still largely active themselves, to IT-integrated computer systems or platforms where software and algorithms perform work processes largely independently and automatically (cf. Table 3).

The automated production tools and the IT-integrated tools can be assigned to the AI applications. The increased use of AI technologies is superseding routine activities across all industries and branches, especially when these are performed on the basis of standardized, structured data and with clear information. Examples include the processing of forms or the monitoring of technical processes.

Table 3: Differentiation of work resources according to the degree of automation and digitization

Application field	Office work	Production work
Tools	Information and communication tools	Means of production, work machinery
Manually controlled/ not IT-supported	Telephones, fax machines or photocopiers; Here humans are to a large extent active themselves	Drilling machines, motor vehicles or X-ray machines; Here humans are to a large extent active themselves
Indirectly controlled/ IT-supported	Computers, terminals, electronic cash registers or CAD systems; Here, technology takes over a large part of the work; humans are indirectly involved	CNC machines, industrial robots or process engineering plants; Here, technology takes over a large part of the work; humans are indirectly involved
Self-controlled/ IT-integrated	Analysis tools on Big Data, cloud computing systems, internet platforms, shopping systems; In these work tools, technology takes over work processes largely automatically	Smart Factory production plants, cyber-physical systems and the Internet of Things; In these work tools, technology takes over work processes

Source: Representation by Arntz et al. 2016

This trend toward automation is particularly noticeable in professions with simple, medium and high task complexity and the resulting demands on the qualifications of employees. It is to be expected that this development will also increasingly encompass activities in which less structured data and more volatile data layers are processed.

In the case of office work, this development is primarily leading to people increasingly performing manual and thus simpler tasks that require situational responses. In the production sector, on the other hand, the trend toward physical work by employees is hardly noticeable, and in some cases is already declining. This is because activities such as securing, protecting and guarding, on the one hand, and repairing, restoring and maintaining, on the other, are also increasingly being integrated into AI technologies. In the area of manual activities, there is also a tendency to assign an assistance function to the working man. In the production sector, digitization is thus obviously accompanied by a relative loss of importance of both routine activities and manual activities. On the other hand, abstract activities such as analyzing, programming, managing employees, developing, researching, designing and negotiating will become much more important, especially in manufacturing companies (Arntz et al. 2016).

3. Competence and competence development

In employment or human resources, **qualification** is understood as a person's suitability for a profession or a specific task, consisting of professional knowledge, social competence and key qualifications. The formal educational and professional qualification is a central element in the placement on the job market. Qualification is needed to perform a variety of job tasks. Thus, qualification is primarily oriented to job demand and not to the subjective interests of a person (cf. Schiersmann 2007).

Acquired professional qualifications do not remain constant, rather they can be improved through experience or company development training. New qualifications are acquired through retraining, among other activities. These instruments serve to develop the qualifications of employees.

While the term qualification denotes the abilities to cope with concrete requirement situations, i.e. it is application-oriented, the term competence is subject-related and not certification-oriented. Competence characterizes the self-organized, creative ability of individuals or groups to act, but also the core competencies of companies and organizations.

There is no generally accepted definition for competence. In the white paper "Competence Development for AI" (André & Bauer et al. 2020), experts from the Plattform Lernende Systeme identified the necessary competencies for dealing with artificial intelligence and illustrate the need for change based on practical role profiles. The authors also outline a model of how competencies can be developed in a targeted, task-oriented manner along a six-stage competence management process.

Ways to develop competence

The term "learning" refers to the intentional or incidental acquisition of skills. The growth in learning can appear in the mental, physical, character or social area. Learning can be understood as an ability to correct previous patterns of action, to take up new patterns and to carry out an adaptation to changed conditions. Thus, learning is a basic human prerequisite for being able to adapt to the conditions of life, to act meaningfully in the environment and, if necessary, to change it with regard to one's own interest. For humans, the ability to learn is also a prerequisite for a reflective relationship to oneself, to fellow human beings and to the environment.

Forms of learning

Learning is essentially based on the comprehension of mental models. Mental models refer to critical reflections that contain basic assumptions. Individual action is actively controlled by the intended mental models. The function of mental models is to bring the inner conception of the nature of things to the surface. This leads to the insight that a world perceived through one's mental models is always incomplete and unsystematic. This insight shall be revealed and abstracted in learning processes. Mental models are mainly used to achieve reflection in learning processes.

The act of learning is differentiated into the aspects of learning process and learning outcome:

- The learning process occurs through social actions and is therefore bound to situation and context. In individual and collective learning processes, information is acquired, interpreted, memorized and conclusions are drawn from it. The results of the learning process cannot always be grasped in words (i.e., implicit knowledge) or clearly measured. For learning processes to be initiated, they must trigger concern among those involved or create a sense of problem pressure that prompts for action. In addition, an intended reduction of uncertainty can trigger a learning process.

- The learning outcome shows what has been learned, i.e. what knowledge has been gained and what improvements have resulted. In both individuals and social systems, successful learning involves a permanent process of adaptation and learning.

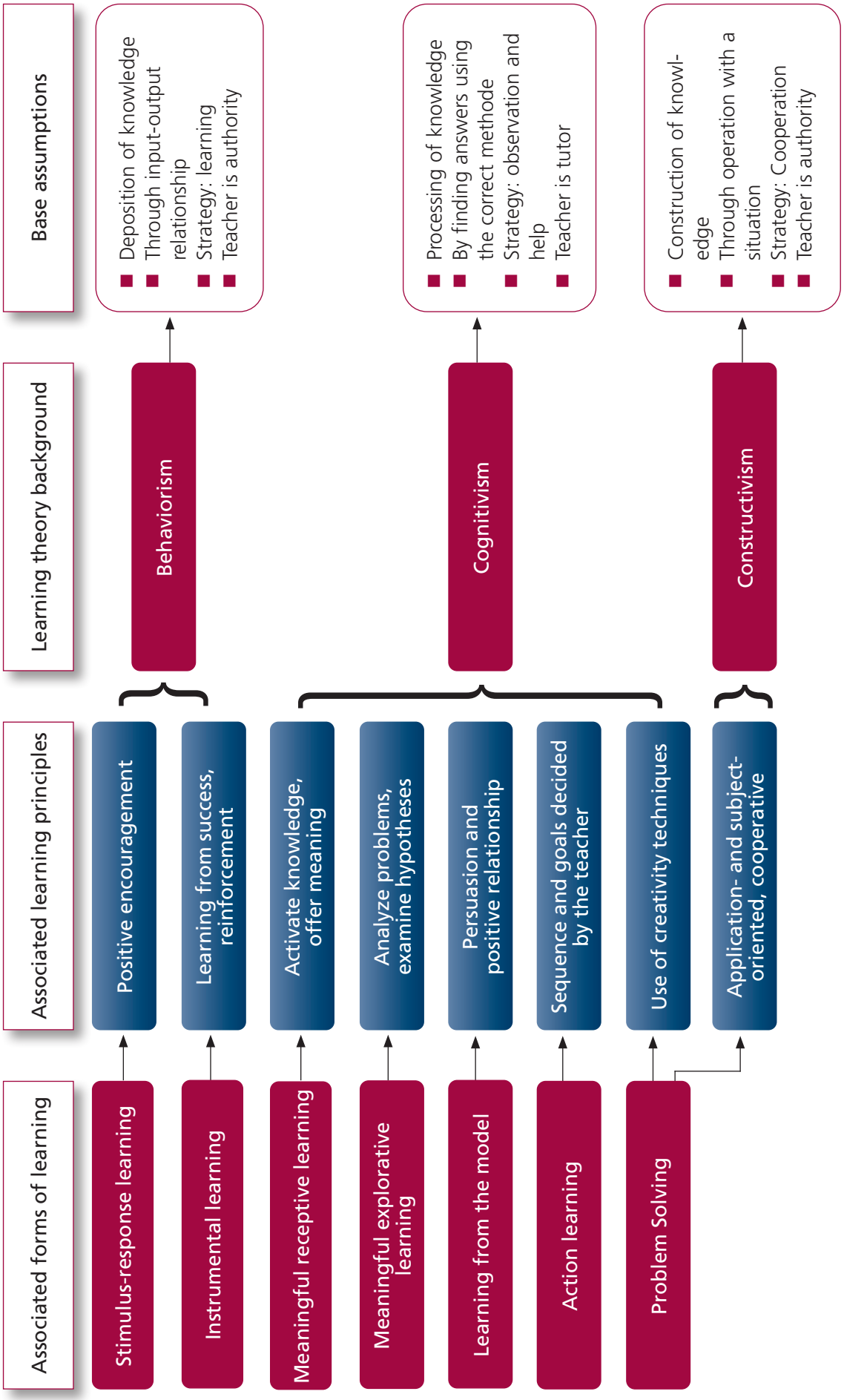
An overview of learning forms and principles is provided in Figure 2 (see p. 13).

Along the learning process and with regard to the learning locations or their methods, different models and concepts of learning are distinguished, which concretize individual stages in the learning process:

- Plan-based (i.e., formal) learning takes place using teaching methods designed to support learning, in the educational system, i.e., through school attendance, adult education offerings, or e-learning. Here, different types of learning have to be distinguished.

- Self-directed (i.e., informal) learning takes place under the assumption that there is an effective learning impulse from the desire for growth in the possibilities of accessing the world, and is not based on an externally planned learning sequence (Holzkamp 1995).

Figure 2: Overview of forms and principles of learning



Source: Own representation (cf. Blumstengel 1998).

Informal learning refers to learning in life contexts, which is seen primarily as learning outside the formal education system. Although adults predominantly learn outside of educational institutions, informal learning has not received the social and scientific attention it deserves in Germany for a long time. Informal job-related learning includes, among other things, attending fairs, participating in events, lectures or seminars, self-learning by observing and trying things out at the workplace, or self-directed learning with the help of self-learning programs. In educational research, however, there is no common understanding of informal learning (Käpplinger 2007). There is agreement, however, that informal learning is supported by working conditions conducive to learning. Table 4 summarizes work-related, formal and informal forms of learning.

Table 4: Work-related forms of learning

Proximity to the task	Pre-professional learning	Occupational forms of learning	
		Supportive means for learning	Educational means
On the job no delimited learning time, learning immanent to work	• Familiarization • Mentoring • Job hospitations, internships	• Project work • Job switching mentoring • Quality circles • Change Labs • Substitution • Work abroad	• Coaching, collegial consultation, experiential learning, tandems • Collegial casework • Trainings • Method rooms • Action Learning
Off the job delimited learning time, work and learning place are separated	• Selection process • Training and education • Junior staff programs	• Development discussions • Performance appraisal • Assessments • Workshops • Professional Communities	• Simulation games • Blended Learning • External trainings • Seminars • Inhouse Trainings • Corporate Universities

Source: Own representation (cf. Olbert-Bock 2010).

Lifelong learning

Lifelong learning, also referred to as learning throughout life, is a concept that aims to enable people to learn throughout their lifespan. Lifelong learning essentially relies on the self and information competence of individuals (Strzelewicz 1984).

Lifelong learning has found its way into many educational concepts in recent decades. The knowledge and skills acquired in school, professional training and the first years of work are increasingly insufficient to master a professional biography and to participate actively in society. In addition, forms of informal learning are emerging as a result of learning in everyday life, changing working conditions and requirements, and the demands of a society in a state of constant change. In addition, there are career paths linked to specific learning outcomes.

Despite these various references to the concept of lifelong learning, no generally applicable definition is yet available. According to the definition of the European Union, lifelong or lifewide learning encompasses "all learning throughout life that serves to improve knowledge, qualifications and competencies and takes place within the framework of a personal, civic, social or employment-related perspective" (Kraus 2001).

4. Study design and methodological approach

The study design consisted of an online survey of operational decision-makers in order to substantiate the conceptual foundations presented in advance with empirical data and to supplement the representations of the white paper Kompetenzentwicklung für Künstliche Intelligenz – Veränderungen, Bedarfe und Handlungsoptionen.

Goals and approach

The survey pursued two goals: First, it was intended to collect data on competence requirements for the use of AI; second, it was intended to identify qualification offerings in clerical and production work.

The question categories and the closed and open questions were designed based on the previous work of the micro-project. The survey was conducted from May 1 to July 15, 2021.

The online survey was promoted via the homepages of the project partners, mailing campaigns and social networks. The analysis of the collected data, the documentation and interpretation of the survey results were carried out after the survey was completed.[2]

A total of N = 50 datasets were included in the analysis. The quantitative and qualitative data collected in the survey were analyzed using descriptive statistical methods. Responses came primarily from specialists and managers with an academic education. Obviously, they provide an indirect perspective on operational business processes. Operational AI actors at the workplace, on the other hand, are difficult to reach via an online survey.

Survey categories

The online survey included the following categories:

- Demographic data
- Information about the company and the field of work
- AI understanding and prior knowledge
- AI applications in the company
- Qualification requirements due to the use of AI
- Training activities in the company
- Training demand with regard to AI technologies

2 The data collection was carried out as part of a micro-project commissioned by the "Plattform Lerndende Systeme" and funded by the Federal Ministry of Education and Research. The questionnaire as well as the collected data are documented and will be provided by the study authors upon request.

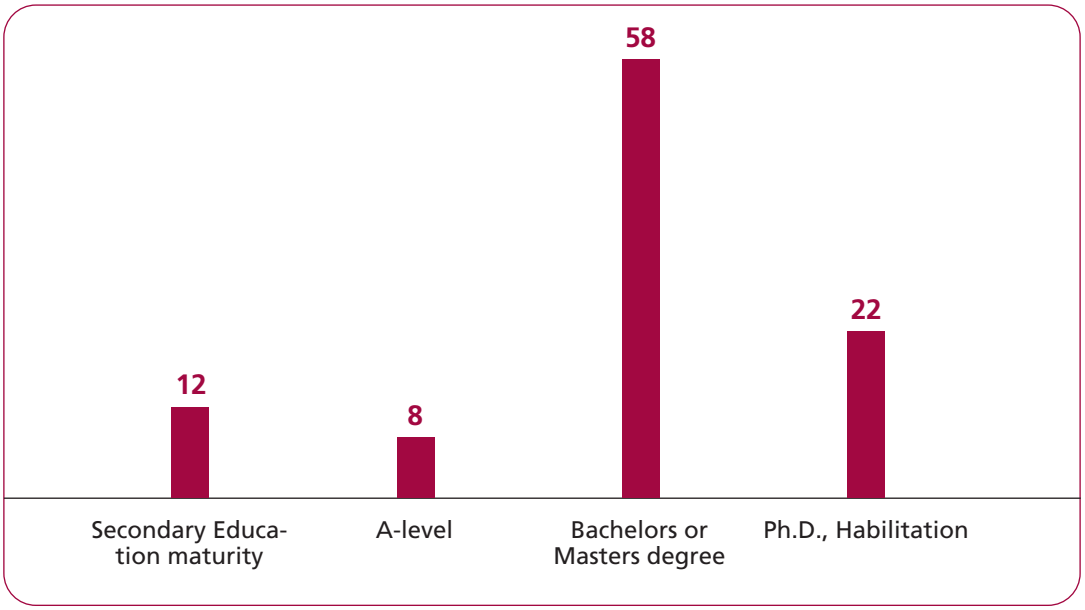
Results of the survey

Socio-demographic data

There were N = 50 respondents taking part in the survey. The age of the respondents varied from 25 to 66 years, with a mean of 44 years. 32 percent of the respondents were female, 68 percent were male.

The educational qualifications were distributed proportionally as follows:

Figure 3: Educational qualifications of respondents (numbers represent percentages)

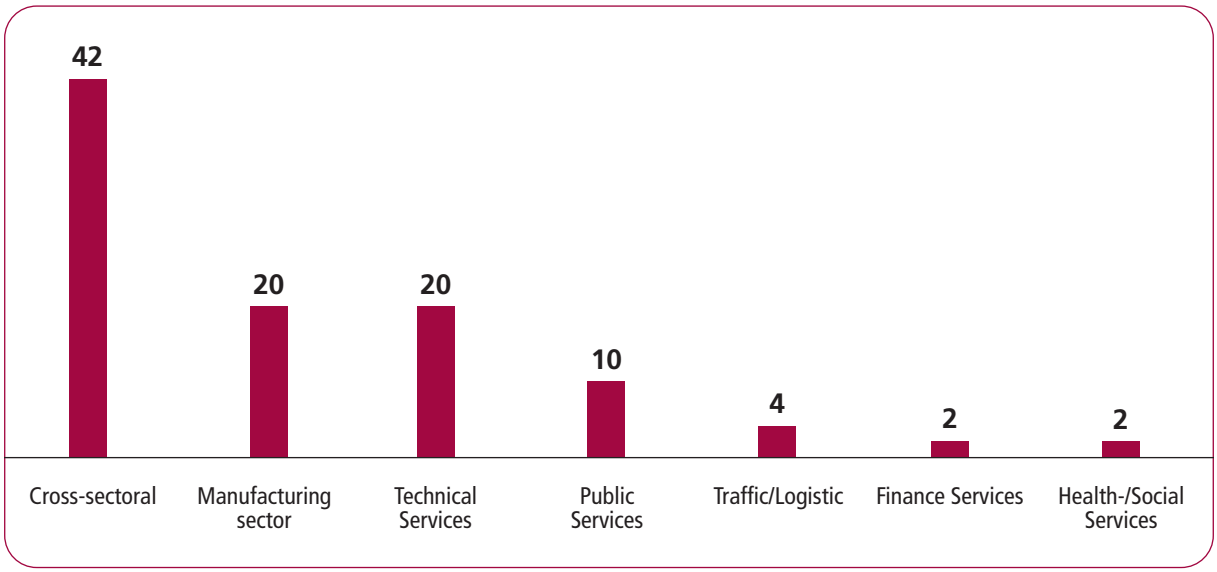


80 percent of the respondents held an organizational position as a manager or specialist. 87 percent of the respondents had a clear understanding of artificial intelligence (AI). However, some respondents noted that the term AI is often used colloquially. This raises high expectations of "strong AI" that cannot currently be met in an organizational context. A majority of respondents have a positive attitude toward AI.

Company related data

The branches which the respondents came from were distributed as follows:

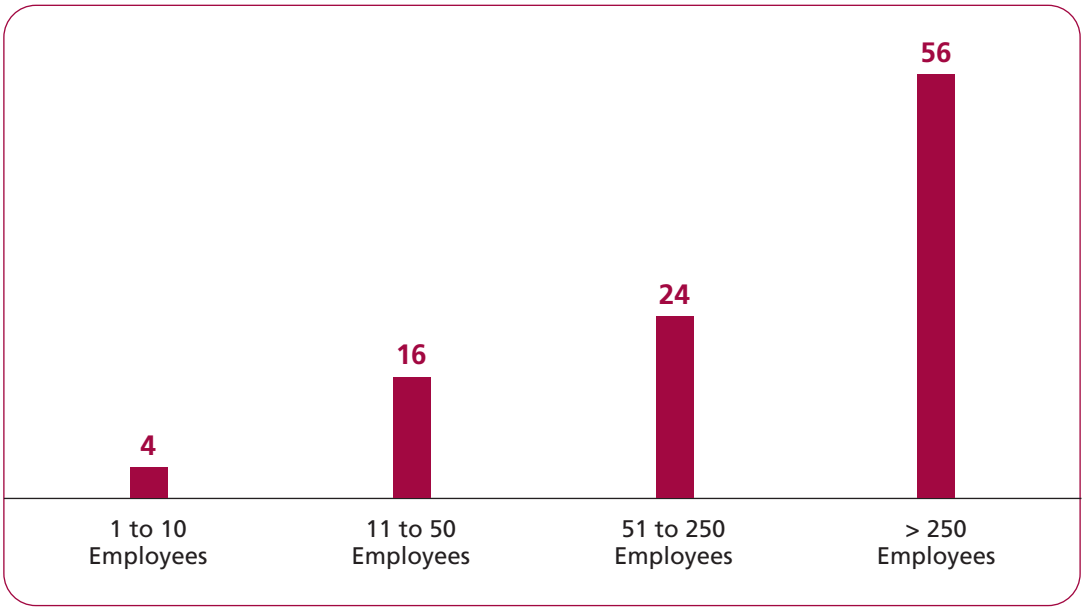
Figure 4: Respondents by industry (numbers represent percentages)



Note: The branches of respondents who selected "Cross-sector" are from, among others: Consulting (17%), Research (11%), IT Development (11%), and Unions (11%).

The company sizes were as follows:

Figure 5: Company size by employees (numbers represent percentages)



The survey shows that AI is primarily an issue in larger companies. 57 percent of respondents stated that their company had already implemented AI applications. These are productive and prototype applications (roughly distributed equally), which in over

70 percent of cases have been in use for longer than a year. 25 percent of respondents have not yet implemented an AI application in their company.

According to their own statements, a considerable proportion of respondents (46 percent) work in higher-level fields and roles that make it difficult to assign them clearly to office or production work on an industry-specific basis. For methodological reasons, it will be largely refrained from differentiating between office and production work in the following.

The goals of an operational AI deployment stated by the respondents are:

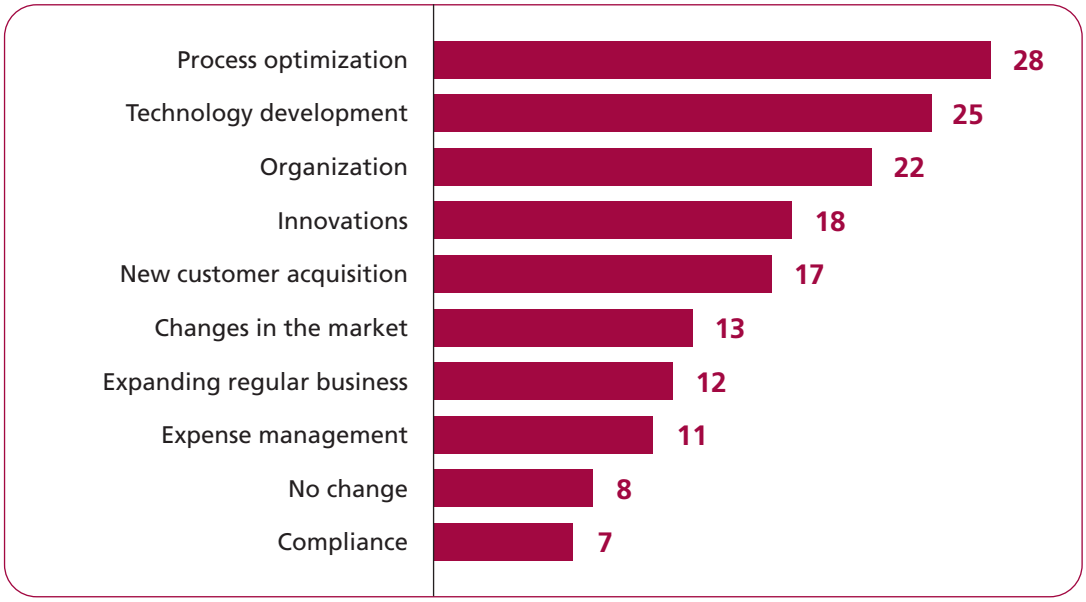
- Cost savings – Increased production – flexibilization
- Streamlining processes – lean administration
- Quality assurance – quality control
- Increasing productivity – forecasting for capacity adjustment
- Evaluation and interpretation of large amounts of machine and process data
- Support and relief of humans – (e.g. chatbot)

The responses show that the deployment of AI in their company essentially follows a technical rationalization paradigm.

Data on the operational use of AI applications

Respondents stated the following reasons for using AI systems:

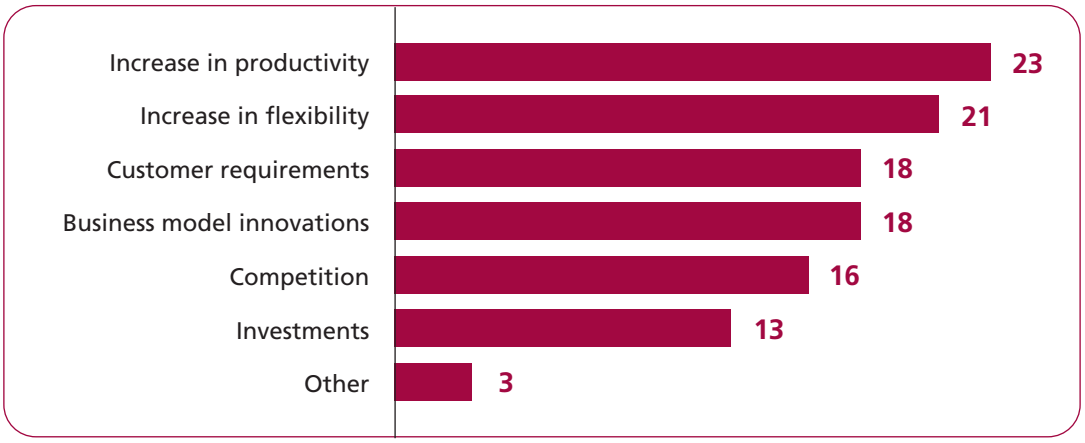
Figure 6: Stated purpose of planned or implemented AI applications
(numbers represent percentages)



Note: N = 50.

Many respondents see the potential benefits of AI in the technical optimization of processes and structures. The respondents commented as follows on the drivers for the use of AI in companies:

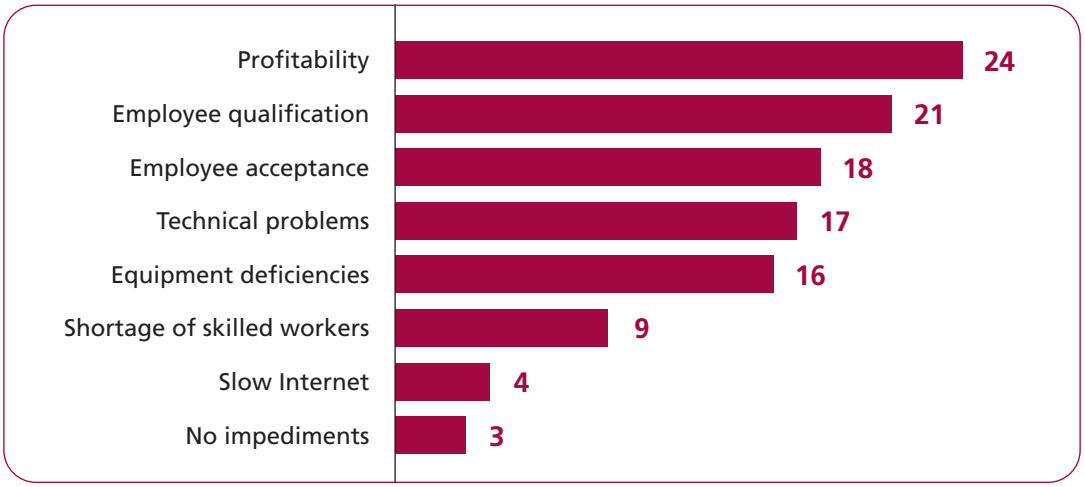
Figure 7: Stated drivers for AI applications



Note: N = 50, multiple answers possible.

The driver factors are significantly shaped by the expected purposes of the use of AI. The focus here is on market requirements in terms of productivity and flexibility. Business model innovations are also discussed. According to the respondents, the driver factors are counteracted by the following impediments:

Figure 8: Stated impediments to AI applications



Note: N = 50, multiple answers possible.

Two impediments dominate the discussion: First, the unclear "return on investment (ROI)" of AI applications, which can involve immense initial investments. However, the "return on investment can often only be assessed after a considerable period of time. Second, employee qualification and acceptance, which confirms the need for appropriate qualification efforts.

As experience shows, the use of AI goes hand in hand with extensive business changes. In the free commentary, the respondents expressed their positive and negative experiences and expectations in this regard as follows:

Table 5: Experiences and expectations of changes through the use of AI

Positive changes	Negative changes
Relieving routine jobs, easing the workload	Worries about job loss due to rationalization
Technological advance	Worries about unstable operation of the AI system
Robotics possible on a higher level	Insufficient reliability of immature AI systems (in terms of quality of results)
Learning progress about methods and their framework	High effort without corresponding benefit
Awareness of viable business models	Dependence on system providers
High user acceptance	Insufficiently practiced data and information protection
More time for customer service	Worries about "robotization" of work (insufficient space for action and decision-making)

50 percent of respondents negated the question of whether the use of AI would change entire job profiles. Twenty-five percent of respondents assume that such a change will occur. They mentioned the following new job profiles:

- Data scientist
- Data manager
- AI operators, MLOps
- Experts for development, testing, infrastructure
- System consultants
- Trainers, educators (changed roles)

Within job profiles, however, the task profiles will change as a result of the use of AI, for example as a result of the addition or removal of requirements. The respondents commented on this as follows:

- Requirements for employees are added: 53 percent
- Requirements for employees are dropped: 20 percent
- No specific indication: 27 percent

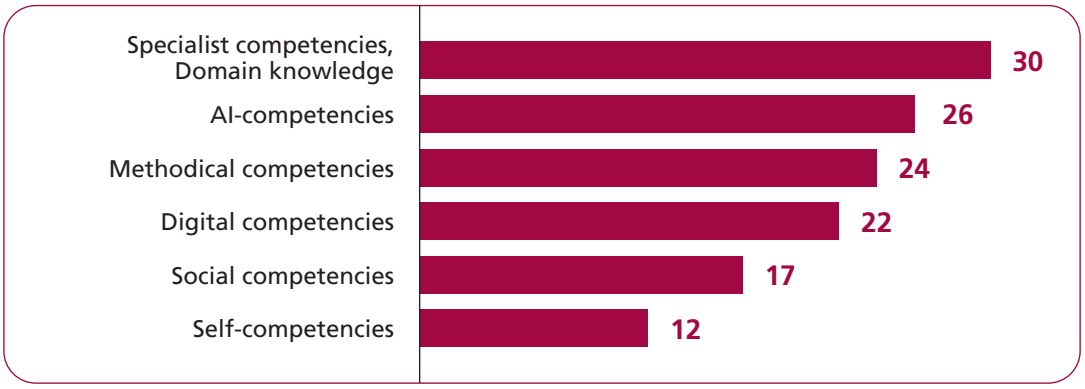
The changed job profiles point to expanded qualification profiles as well as to the need for qualification in companies in the transformation process.

Data regarding AI competencies and qualification measures

86 percent of respondents stated that their company has a (general) training program for which a contact person is responsible.

The question of whether the company's employees already have specific AI skills was answered positively by 49 percent of respondents. 38 percent identified skills gaps. 13 percent did not provide any specific information. The respondents' answers reveal a considerable need for qualifications to impart appropriate competencies in the use of AI. When asked what specific types of skills are required for the use of AI, the respondents answered as follows:

Figure 9: Qualification requirements for AI deployment



Note: N = 50, multiple answers possible.

The qualification basis for the use of AI is therefore specialist related competence, i.e. profound knowledge of business models, customers, processes and technologies that are to be optimized or renewed for AI. In addition, AI and digital competence are of great importance. AI competencies relate primarily to technology, while digital competencies are more system-related. Social and personal skills, on the other hand, are not the focus of the respondents' requirements.

Companies are seeking various ways to compensate for possible knowledge deficits in the use of AI through knowledge transfer. Most of the mentions relate to in-house training activities. This is supplemented by the establishment of specialist departments within the company. Some companies involve external knowledge suppliers (for example, by recruiting qualified junior staff or by having tasks supervised by external staff).

Figure 10: Forms of knowledge acquisition and transfer for AI deployment

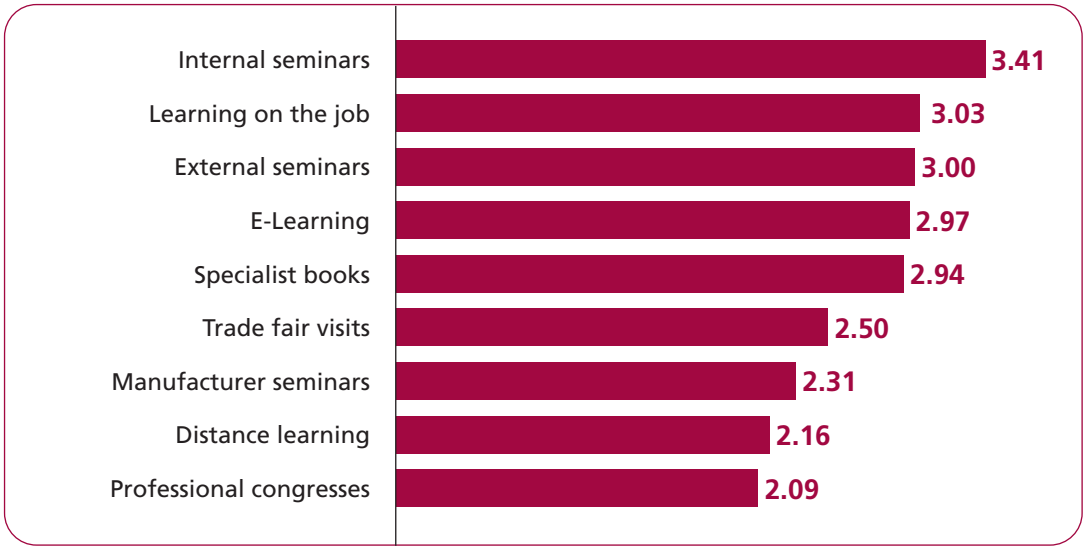
Note: N = 50, multiple answers possible.

In view of the great importance of in-house qualification, the survey addressed the current status of relevant qualification measures. 51 percent of respondents confirmed that their company is already carrying out AI qualification measures. 30 percent of respondents negated the question. If qualification measures are carried out, the following occasions and objectives are decisive:

- Learn about AI technologies and their potential
- Expanding the decision-making basis (including that of management and works council)
- Learn about immediate practical application
- Reduce fears of excessive demands, increase acceptance

In view of the variety of in-company and inter-company forms of learning (cf. Table 4), their current company preference was surveyed.

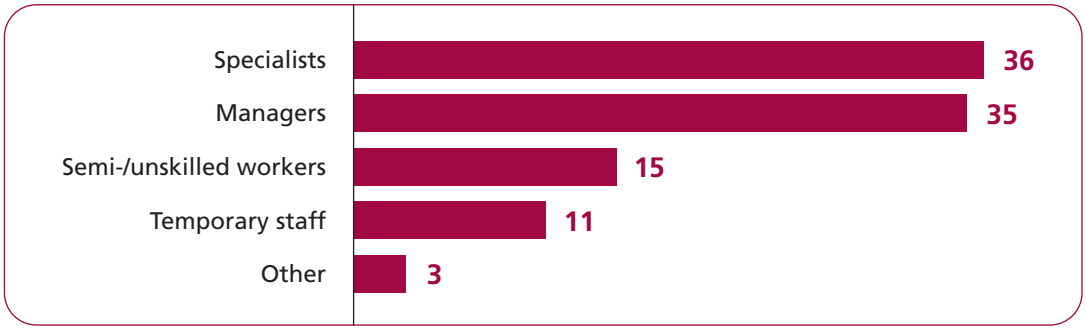
Figure 11: Forms of learning practiced as part of general training programs in the companies



Note: N = 50, mean of rating from 1 (low) to 4 (high).

Internal seminars and training-on-the-job are highly preferred. By contrast, distance learning courses and specialist congresses are only of secondary importance. E-learning courses and external training courses have potential for further development. When asked which employee groups take part in training measures, the response was concentrated on specialists and managers. Around 89 percent of respondents would like to take part in such training measures themselves.

Figure 12: Target groups for AI qualification offer
(numbers represent percentages)



The largest group of people participating in general training programs in the company are those aged from 30 to 39, followed by those under 30 and between 40 and 49.

5. Analysis and interpretation of the survey results

The data acquired in the online survey were analyzed using methods of descriptive statistics. However, the relatively small sample (N = 50 data records) precludes an overly differentiated evaluation. Nevertheless, core statements from the survey of company experts can be summarized.

These key statements were presented to a panel of experts organized by the "Plattform Lernende Systeme" at the end of September 2021 as part of a public webtalk. Moderated by Professor Wilhelm Bauer (Fraunhofer IAO), the following experts discussed the topic of "Which competencies empower employees in the AI age?":

- **Dr. Andreas Bildstein**, Mittelstand 4.0 Competence Center Stuttgart
- **Uta Kupfer**, ver.di
- **Katharina Schüller**, STAT-UP GmbH
- **Andrea Stich**, Infineon Technologies AG
- **Prof. Dr. Sascha Stowasser**, ifaa e. V.

Selected quotes from the panelists, which are marked as such, are used to supplement the core statements of the survey documented in the following.

The topic of AI is currently being discussed primarily at a strategic and exploratory corporate level

As intended in the study design, company decision-makers were surveyed. These are primarily specialists and managers with an academic education. For obvious reasons, they can provide an indirect perspective on operational business matters. Operational AI stakeholders with their specific experiences and expectations, on the other hand, are difficult to reach in the workplace for a scientific survey.

> AI must not be introduced top down; rather, AI competence development must be designed as a change management issue in dialog with employees.
> **Andrea Stich** (Infineon Technologies AG)

The responses also show that the use of AI in companies is currently being discussed primarily from a strategic perspective. Many companies are currently in an introductory and exploration phase of AI. Professionals and managers sometimes have only limited insights into the expectations of employees when it comes to the use of AI technologies.

The answers of the respondents refer primarily to topics across applications, which makes a sector-related differentiation of AI activities with regard to production and clerical work less relevant in practical terms.

> It remains to be shown whether the same set of AI competencies will be required for all roles in the future - albeit to different degrees - or whether completely different competencies will be needed for different roles. **Katharina Schüller** (STAT-UP)

A technical-functional view dominates the introduction of AI

The main motives for using AI are to meet customer requirements, further develop the business model, increase productivity and reduce costs. Thus, the respondents describe target categories that have been targeted for some time by means of strategies of technical and economic rationalization.

The authors derive from this report and the survey data a considerable need for specialist expertise as well as domain knowledge (cf. strategy of "upgrading") resulting from an increased use of AI applications. This need was widely confirmed by the panel experts and placed in the context of comprehensive, operational change management.

> A change management process should be oriented towards four phases: 1) Objectives and impact assessment: For what do I need AI? What are the goals of AI? What consequences are to be expected for employees?; 2) Planning and design: What criteria must be fulfilled so that AI systems are designed to be human-friendly?; 3) Preparation and implementation: What qualification needs arise from AI systems and how can corresponding competencies be built up?; 4) Evaluation and adaptation: What conclusions can be drawn from operational practice, where do improvements need to be made? During these four phases, it is extremely important that all stakeholders in the company talk to each other. **Sascha Stowasser** (ifaa e. V.)

Despite the need for acceptance among employees during the introduction of AI, there are only a few explicit references to a human-centric design approach in the responses. Consequently, a corresponding need for qualification in socio-technical system design is articulated rather cautiously. Instead, the focus is on the transformation and change processes; in order to successfully master these processes, it is necessary to strengthen employees' personal and social competencies.

> Competencies combine the components of knowledge, application, and reflection: awareness of major ethical issues should therefore be sufficiently conveyed in an AI competence development. **Katharina Schüller** (STAT-UP)

The concern for a human-centered design approach for AI systems and for ethically responsible AI application is expected to trigger a more extensive need for qualification in the context of socio-technical work system design in the future.

> All stakeholders must be involved in the change process. Employees need a clear mandate and a perspective in the sense of certainty in planning. Works councils and staff councils have a special role to play here. **Uta Kupfer** (ver.di)

A need for further qualification is becoming apparent

The survey reveals that many companies are in the introductory phase of AI technologies. Widespread use of AI and technical progress are expected to increase the need for qualifications in the future. At the same time, company-specific domain and process knowledge must be further developed, and personal and social competencies must be fostered for operational change.

> It is important for small and medium-sized companies, often as pure AI appliers, to have a basic understanding of how data-based AI systems work technically. Consequently, there must also be training opportunities for less qualified skilled workers.
> **Andreas Bildstein** (Mittelstand 4.0 Kompetenzzentrum Stuttgart)

Companies pursue different strategies for building up competencies: On the one hand, existing competencies are further developed through an in-house qualification strategy. On the other hand, companies recruit qualified junior staff and experienced experts on the job markets in order to meet their competence requirements.

> The job market will decide which company will receive the available AI experts. Small and medium-sized companies and rural companies will face a tougher challenge. Just bringing in external expertise will be too expensive. That is why it is necessary to build up the company's own expertise. **Sascha Stowasser** (ifaa e. V.)

Current qualification offerings focus primarily on (technical) specialists and managers in the age group from 30 to 39. AI-specific training measures for low-skilled workers (including temporary workers) have so far only been provided to a lesser extent. However, as AI applications become more widespread, operational employee groups should also be increasingly included. This will not at least counteract a digital divide among employee groups and make the deployment of personnel in companies more flexible. In addition, relevant training opportunities should also be opened up for older, experienced employees.

> The age of the employees is often not the decisive problem for a successful AI implementation. Rather, a negative mindset among decision-makers can slow down the introduction of AI. **Andreas Bildstein** (Mittelstand 4.0 Kompetenzzentrum Stuttgart)

Qualification programs integrate learning and action at work

AI qualification activities are currently preferably carried out as task-specific "on-the-job training" or in-house seminars. Relevant qualification concepts emphasize the integration of learning and action at work: This promotes the target-oriented implementation of new experiences in practical action. This has a lasting impact on operational change processes. At the same time, knowledge pools can be updated and AI qualifications can be integrated into existing training structures.

> Companies need AI competencies on the one hand from experts who develop AI and on the other hand from specialists who apply AI. Not all employees who work with AI have to be data scientists. Rather, everyone should be given a task in the field to which she/he can contribute, and she/he must be qualified for. **Andrea Stich** (Infineon Technologies AG)

However, learning close to the workplace can, under certain circumstances, limit the productivity of efficiency-oriented work processes. At the operational level, it is a constant challenge to balance the tension between innovation and consistency, between "exploration" and "exploitation".

> Learning-on-the-job is a double-edged sword, but it makes perfect sense. Digital education formats should be supplemented with classroom formats. Companies must provide suitable learning spaces for this purpose. **Uta Kupfer** (ver.di)

Qualification programs (in the workplace) are also supplemented by a variety of media offerings and formats. Multimedia forms of knowledge transfer open up far-reaching innovation potential for training providers.

6. Conclusions

The introduction of artificial intelligence (AI) in companies significantly shapes the task and role profiles of employees. Companies are challenged to qualify their employees at an early stage. Competence development as continuing education in the sense of lifelong learning and learning integrated into their work are central strategies for enabling companies and their employees for the AI age. AI competencies are required in all company domains and for different roles. They affect the technical, organizational and social-ethical dimensions of work. The white paper "Kompetenzentwicklung für Künstliche Intelligenz – Veränderungen, Bedarfe und Handlungsoptionen" provides an overview of the competence requirements in the AI age (André & Bauer et al. 2021).

The purpose of the presented study was to collect relevant data by means of an online survey of company experts in order to supplement the explanations in the white paper with empirical findings. In addition to the requirements for competence development with regard to AI applications, the focus of interest was on the survey of company offerings for AI qualification in clerical and production work. The evaluation of the survey results included 50 complete data sets. The expert survey was preceded by an extensive literature research.

The survey results reveal that artificial intelligence is currently being discussed primarily in an exploratory context at the strategic company level. Most company representatives reported on prototypes and pilot applications, sometimes also on productive AI applications. In the context of introducing AI applications, a technical-functional view dominates, although human-centered aspects or corresponding qualification needs are recognized as foundations critical to success; deficits in this regard often hinder the successful implementation of AI applications in company practice.

In terms of qualifications, there is a primary need for further training, especially for IT specialists and managers, which will become more constant as AI technology advances and is applied. The prioritized age group for training activities is from 30 to 39 years. Educational activities for low-skilled workers (including temporary workers) are carried out far less frequently. Knowledge is built up primarily through in-house qualification activities, but also by recruiting experts on the job markets, insofar as these can be reached at all, especially by medium-sized companies. AI-specific qualification activities are preferably carried out as "on-the-job training" or "in-house seminars". The integration of learning and acting is intended to strengthen the company's practical application.

The results of the online survey were presented to a expert panel, who were invited by the "Plattform Lernende Systeme" to participate in a public webinar in September 2021. These experts widely corroborated the survey results and concretized them. On the one hand, it was recommended that the topic of competence should be understood as a building block of systematically pursued change management. On the other hand, the importance of social-communicative competencies and ethical values for the sustainable management of operational change was emphasized.

The expert discussion made clear that the operational use of intelligent systems is not merely an end in itself. Rather, they are intended to enable companies and the employees to meet the needs of their customers in an ever better, creative and economical manner. For this purpose, they complement the diverse human capabilities – which are ultimately based on cognitive, emotional and ethical decision-making abilities. They can never fully replace these abilities of humans, nor their sense of responsibility.

Literature

André, E. & Bauer, W. et al. (Hrsg.) (2021): Kompetenzentwicklung für KI – Veränderungen, Bedarfe und Handlungsoptionen. White paper aus der Plattform Lernende Systeme. München. Online abrufbar unter: https://www.plattform-lernende-systeme.de/files/Downloads/Publikationen/AG2_WP_Kompetenzentwicklung_KI.pdf
DOI: https://doi.org/10.48669/pls_20212.

Apt, W., Bovenschulte, M., Hartmann, E. A. & Wischmann, S. (2016): Foresight-Studie „Digitale Arbeitswelt". Forschungsbericht 463 für das Bundesministerium für Arbeit und Soziales. Berlin: Institut für Innovation und Technik.

Bartscher, T. & Nissen, R. (2017): Personalmanagement, 2. Auflage.
Hallbergmoos: Pearson.

Blumstengel, A. (1998): Entwicklung hypermedialer Lernsysteme. Dissertation an der Universität Paderborn. Berlin: Wissenschaftlicher Verlag.

Braun, M. (2017): Arbeit 4.0: Der gesunde Mensch in der digitalisierten Arbeitswelt.
In: Nowak, D., Letzel, S. (Hrsg.), Handbuch der Arbeitsmedizin [S. 1–24].
Landsberg: Ecomed.

Holzkamp, K. (1995): Lernen. Subjektwissenschaftliche Grundlegung. Frankfurt: Campus.

Käpplinger, B. (2007): Abschlüsse und Zertifikate in der Weiterbildung. Dissertation an der Humboldt-Universität Berlin. Bielefeld: Bertelsmann.

Kraus, K. (2001): Lebenslanges Lernen – Karriere einer Leitidee. Bielefeld: Bertelsmann.

Lenzen, M. (2019): Künstliche Intelligenz: Was sie kann & was uns erwartet.
München: Beck.

Olbert-Bock, S. (2010): Baukasten für ein strategisches Personalentwicklungskonzept.
KMU-Magazin 13. Nr. 6, S. 70–75.

Schiersmann, C. (2007): Berufliche Weiterbildung. Berlin: Springer.

Spath, D., Hämmerle, M., Krause, T., Schlund, S., Ganschar, O. & Gerlach, S. (2013): Produktionsarbeit der Zukunft – Industrie 4.0. Stuttgart: Fraunhofer IAO.

Strzelewicz, W. (1984): Lebenslanges Lernen als Bildungsaufgabe in sozialhistorischer Sicht. In: Ruprecht, H., Sitzmann, G. (Hrsg.), Erwachsenenbildung als Wissenschaft.
Wellenberg: Weltenburger Akademie.

About this report

This paper was prepared in collaboration with the working group Future of Work and Human-Machine Interaction of the Plattform Lernende Systeme. As one of a total of seven working groups, it investigates the potentials and challenges arising from the use of artificial intelligence in the world of the workplace and life. The focus is on questions of transformation and the development of humane working conditions. It is also 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.

Authors from the project team
Prof. Dr. Elisabeth André, Universität Augsburg
Prof. Dr.-Ing. Prof. e. h. Wilhelm Bauer, Fraunhofer-Institut für Arbeitswirtschaft und Organisation IAO und Universität Stuttgart
Dr. Martin Braun, Fraunhofer-Institut für Arbeitswirtschaft und Organisation IAO und Universität Stuttgart
Dr. Chi-Tai Dang, Universität Augsburg
Dr.-Ing. Matthias Peissner, Fraunhofer-Institut für Arbeitswirtschaft und Organisation (IAO)
Katharina Weitz, Universität Augsburg

Interviewed experts
Andreas Bildstein, Mittelstand 4.0-Kompetenzzentrum Stuttgart
Uta Kupfer, ver.di
Andrea Stich, Infineon Technologies AG
Prof. Dr.-Ing. Sascha Stowasser, Institut für angewandte Arbeitswissenschaft (ifaa)
Katharina Schüller, STAT-UP Statistical Consulting & Data Science GmbH

Translation
Dr. Chi Tai Dang, Universität Augsburg
Katharina Weitz, Universität Augsburg

Editorial
Alexander Mihatsch, Geschäftsstelle der Plattform Lernende Systeme
Dr. Ursula Ohliger, Geschäftsstelle der Plattform Lernende Systeme

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, Munichs

Status
December 2021

Image credit
Gorodenkoff/Adobe Stock/title

For questions or comments about this publication, please contact Johannes Winter (head of the managing office):
kontakt@plattform-lernende-systeme.de

Follow us on Twitter: @LernendeSysteme

Recommended citation
Elisabeth André & Wilhelm Bauer et al. (Hrsg.):
AI competence development in office and production work. Project Report from Plattform Lernende Systeme, Munich. https://doi.org/10.48669/pls_2021-4