

AI-SPECIFIC COMPETENCIES - REQUIREMENTS FOR THE FUTURE WORKPLACE

Arno Onnen

Department of Information Sciences, University of Library Studies and Information
Technologies (UNIBIT), Bulgaria

E-Mail: arno.onnen@gmail.co

Abstract: *The article examines the impact of artificial intelligence (AI) on future workplace competencies and requirements. Based on an extensive literature review, competency models are developed to define the skills necessary for the effective use of AI. Key areas include technical knowledge, the operation of AI systems, and their social and ethical implications. Specific competencies such as data analysis, programming, ethical decision-making, and problem-solving are highlighted. Furthermore, the article emphasizes the need for companies to foster lifelong learning to continuously adapt employees' digital and AI-related skills. The study also identifies disparities in AI adoption between small and large enterprises and highlights challenges such as employee qualification and change management. Finally, it underscores the necessity of systematically developing both technical and social skills to meet the demands of an AI-driven workplace.*

Key Words: AI COMPETENCIES, COMPETENCE MODELS, AI LITERACY, DIGITAL TRANSFORMATION, PROFESSIONAL DEVELOPMENT

INTRODUCTION

The rise of artificial intelligence (AI) from a promising technology to a central component of modern economic life is fundamentally changing the way we work (see Hasenbein 2023: 3). Machine learning, neural networks and automated decision-making are already characterizing today's workplaces. These changes not only affect large technology companies, but also organizations of all sizes and from all sectors. A study by Fraunhofer AIO predicts that AI will play an increasing role in all areas of business, particularly in data-related tasks, which will require new roles and skills as a result (Dukino et al. 2019: 32).

However, this transformation goes beyond mere technological adjustments and affects all aspects of a company - from strategy to corporate culture. Companies are forced to realign their business models in order to remain competitive and meet the changing needs of society (Hasenbein 2023: 36-38).

Von See describes digital transformation as a process in which the use of new technologies and digitalized business models increases flexibility and productivity and enhances customer orientation (Von See 2019: 28). AI plays a central role in this context, as it helps companies to increase their competitiveness, drive innovation and promote sustainable growth (Plattform Industrie 4.0 2021: 4).

In Germany, around 12% of companies use AI technologies, with large companies doing so far more frequently than small and medium-sized enterprises. While a third of large companies use AI, the figure is 16% for medium-sized companies and only 10% for small companies. The use of AI is focused on accounting, controlling, IT security and production processes. Speech recognition and the automation of work processes are among the most widely used AI technologies (Destatis 2023: 1). AI in the form of assistance systems is becoming advisors and partners to decision-makers, particularly in management tasks (Bitkom 2017: 43).

The qualification of employees is a frequently mentioned challenge in the introduction of AI (Stowasser et al. 2020: 2). By 2030, the demand for technology-related skills is expected to increase by 55% and for social and emotional skills by 24%. Companies must ensure that their employees acquire the necessary skills to be able to use AI systems effectively (McKinsey 2024: 27).

Competences include all skills, knowledge and attitudes required to successfully complete tasks (Kauffeld et al. 2018: 14).

Hofmann et al. emphasize the importance of the management level in promoting digital transformation through an adapted attitude and agile forms of work. A culture of lifelong learning, the involvement of employees and the promotion of personal responsibility are key success factors (Hofmann et al. 2020: 7-9; Onnen, A. 2024: 9-10).

Skills development, initiated among other things by creating a framework that is conducive to learning and through targeted further training, is a central task of company management in order to meet the changing skills requirements. It is becoming increasingly necessary for companies and their employees to develop and continuously adapt digital skills (Ludwig et al. 2023: 101; Berninger-Schäfer 2020: 18).

RESEARCH METHODOLOGY

As part of this publication, a literature analysis on AI-specific competence requirements was carried out. The literature review includes books, journals, research papers and online articles as well as websites, which are used in particular for the consideration of competences in the field of AI literacy.

The sources analyzed consist of studies on digital and AI-related competences and competence models, as well as sources on general competences for the application of artificial intelligence in the general public.

RESULTS

André et al. categorize the task- and role-specific competences required for working with AI into three areas:

- (1) Expertise and basic knowledge
- (2) Dealing with AI systems
- (3) Designing the context of AI systems (André et al., 2021: 18-19).

Table 1: Competency requirements identified by André et al.

Technical and basic knowledge
Professional expertise
Subject-specific knowledge and skills to cope with daily tasks
Basic digital skills
Confident handling of digital technologies and knowledge of security aspects
AI awareness
Understanding of the capabilities and limitations of AI systems and the type of data processed
Development and handling of AI system
Human-machine interaction skills
Effective use of interaction systems
Basic knowledge of machine learning
Understanding of ML, deep learning and neural networks
Skills in programming languages, platforms, frameworks and libraries
Knowledge of programming languages such as Python and common platforms
Big data, data science and data analytics
Skills in handling large amounts of data and data ethics
Process and system expertise

Understanding and structuring of business processes
Problem-solving skills and resilience
Developing solution strategies for unexpected difficulties
Reflection skills
Critical evaluation of the results of AI systems
Shaping the context of AI
Self-competencies
Personal responsibility and willingness to learn new technologies
Social and communication skills
Collaboration in interdisciplinary teams and communication with customers
Management, leadership and change management skills
Coordination of teams and promotion of further training opportunities
Adaptability and transferability
Adaptation to new challenges caused by AI

Table 1 presents AI-specific competencies, which vary depending on the role and task, according to André et al. It becomes evident that the broad application of AI requires a wide range of diverse competencies (own representation based on André et al. 2021: 18, 19).

Daniels et al., through a literature review, analyzed AI-specific competency requirements and, based on their findings, defined three central competency areas: (1) Working with and designing for AI (2) Personal skills for AI-related fields of action (3) Shaping the social environment with and for AI These competency areas encompass a total of 12 competency fields (see Table 2) (Daniels et al. 2023: 234-235).

Table 2: AI-specific competency requirements according to Daniels et al.

Area	Competence	Description
Innovation and creative design with and for AI	Digital competence	Utilization and development of AI tools and applications, alongside a reflective, critical understanding of the technical functionalities of AI in relation to both society and the individual
	Design Thinking Competence	Application of creative development processes and collaboration in problem-solving within the context of AI
	Innovation competence	Willingness to foster AI innovations within organizations and across processes
	System competence	Understanding of AI systems in complex social and technical contexts and their integration into larger systems

Autonomous action with and for AI	Decision-making competence	Recognition and evaluation of decision-making situations in the AI context
	Ethical competence	Awareness and evaluation of ethical issues related to AI
	Learning competence	Willingness and ability to engage with AI-related topics and to learn through AI applications
	Reflection competence	Critical reflection on value systems and behavioral patterns associated with AI
	Self-determination	Autonomous action despite the constraints set by data and AI algorithms
	Self-competence	Use of AI tools for personal and professional development, self-organization, and time management
Co-creation with and through AI	Future and design competence	Creativity and openness to new, forward-looking developments in the field of AI
	Cooperation competence	Ability to collaborate in interdisciplinary and inter-organizational AI projects
	Communication skills	Ability to communicate and engage in dialogue appropriately within the AI context

Table 2 presents the competency areas and competencies identified by Daniels et al. for the application of AI in organizations (Daniels et al. 2023: 234-235).

Based on an extensive literature review on AI literacy, Long et al. have identified the following fundamental core competencies for engaging with AI (Long et al., 2020: 4-7).

Table 3: AI-Literacy Competencies according to Long et al. 2020

Competence	Description
Recognizing AI	The ability to distinguish between technological artifacts that utilize AI and those that do not.
Understanding Intelligence	Critical analysis and discussion of what constitutes intelligence in an entity, including the differences between human, animal, and machine intelligence.
Interdisciplinarity	Recognition that there are multiple approaches to developing "intelligent" machines and that AI technologies are applied across various fields.
AI's Strengths & Weaknesses	Identifying tasks that AI can perform well and those that pose challenges for AI.

Imagine Future AI	Imagining potential future applications of AI and evaluating their impact on the world.
Representations	Understanding how AI represents knowledge and recognizing examples of knowledge representation.
Decision-Making	Understanding how computers make decisions and identifying examples of this process.
Machine Learning Steps	Comprehending the steps involved in machine learning and the challenges associated with each phase.
Human Role in AI	Understanding that humans play a crucial role in programming, model selection, and the fine-tuning of AI systems.
Data Literacy	Grasping fundamental data literacy, particularly in the context of AI and machine learning.
Learning from Data	Recognizing that computers learn from data, including personal data.
Critically Interpreting Data	Critically interpreting data and understanding how training data can influence the outcomes of algorithms.
Action & Reaction	Understanding that some AI systems can physically interact with the world.
Sensors	Recognizing that computers perceive the world through sensors and understanding how sensors function.
Ethics	Identifying and describing ethical issues related to AI, such as privacy, employment, transparency, bias, and accountability.

Table 3 presents the competencies identified by Long et al. for the application of artificial intelligence.

In a study on AI-related competencies in broader society, Hofmann identified the following competencies (see Table 4):

Table 4: AI-specific Competencies according to Hofmann.

Competency Area	Description
Critical-reflective and cognitive skills	Critical evaluation and reflection on the functioning of AI, algorithms, and their impact on daily life.
Instrumental and qualification-based skills	Understanding how algorithms and automated communication work. Knowledge of the technical foundations and functionalities of AI systems. Understanding how AI-based applications (e.g., voice assistants, smart toys) function in everyday life.

Data literacy	The ability to interpret and analyze data, particularly in the context of AI applications. Understanding how AI learns from data and how algorithms are trained.
Emotional and social skills	Handling the social and emotional aspects of AI, especially in the realm of social interaction and communication with AI systems.
Creative problem-solving	Creativity in working with AI to develop innovative solutions and explore new fields of application.
Algorithm awareness	Awareness of how algorithms process information, particularly in social media and other online platforms.

The competencies presented in table 4 aim to enable users to effectively utilize and critically evaluate AI technologies across various areas of life (Hoffmann 2021: 3-4).

In relation to the use and application of AI, Teuber et al. propose a three-tiered generalized competency model.

- Level 1 includes competencies for the application of AI, relevant for the general population.
- Level 2 encompasses competencies for AI-associated roles, or occupations where AI is applied.
- Level 3 includes competencies for AI experts—such as data analysts or roles involved in developing machine learning algorithms (Teuber et al. 2022: 105).

The three competency levels cover the following areas:

- Programming
- Data Literacy
- AI Ethics
- Machine Learning

This results in a competency matrix with AI-related competencies assigned to each level and area (see Figure 1).

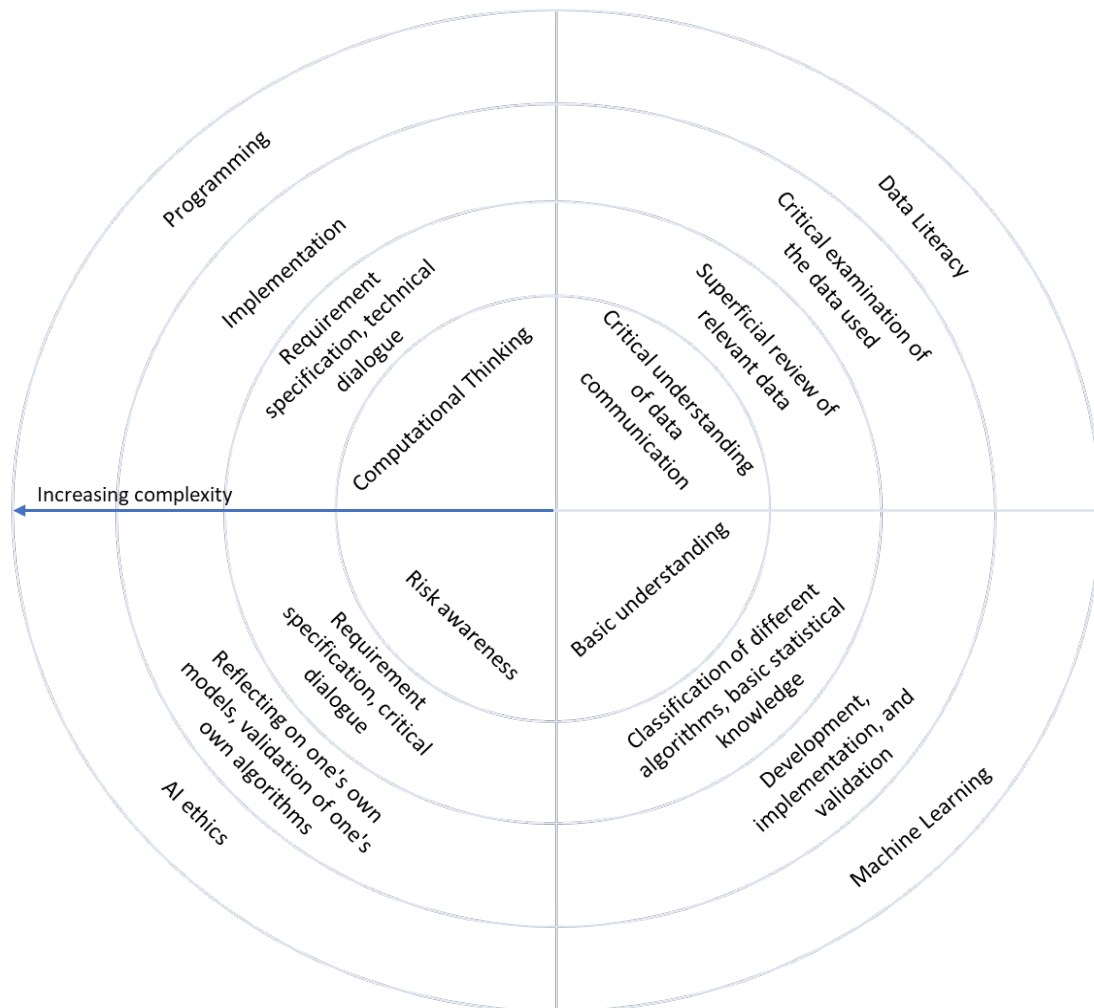


Figure 1: Competency Models for the Application of AI (Teuber et al. 2022: 105)

Figure 1 illustrates the competencies relevant to AI application, as examined by Teuber et al., categorized into the areas of programming, data literacy, machine learning, and AI ethics. As the complexity of the requirements increases, the necessary abilities for action evolve accordingly (Teuber et al. 2022: 105).

Baumgartner et al., in an exploratory study among corporate representatives, identified AI-related competency needs within companies. The study highlights the following competencies (Baumgartner et al. 2023: 3-5):

Table 5: AI-related Competency Needs in Companies according to Baumgartner et al.

Competency Area	Description
Technical understanding of AI applications	The ability to understand the functioning of the AI application being used and to assess its performance.
Ability to analyze structured and unstructured data (Data Science)	The competence to correctly analyze and interpret data processed by AI systems.
Programming skills	Basic programming skills, particularly in programming languages such as Python, R, Java, or Scala, to further customize and optimize AI applications.
Awareness and basic understanding of data protection	The ability to identify data protection risks when using AI systems and to handle them responsibly.
Ability to facilitate AI implementation	The competence to lead teams through change processes and ensure that all participants understand the implementation of AI technologies.
Explanation and support for employees	The ability to explain the functioning of AI to employees and provide support in its usage.
Legal and ethical knowledge	Knowledge of the legal frameworks and ethical implications associated with the use of AI systems.

Table 5 presents the competency needs for the application of AI in companies. It becomes clear that specialists and managers are required to moderate and communicate the AI-specific digital transformation (Baumgartner et al. 2023: 3-5).

Ng et al., in a literature review of 30 articles on AI literacy, identified AI-related competency areas (Ng et al. 2023: 3-9).

Table 6: AI Literacy according to Ng et al.

Competency Area	Description
Technological Knowledge	Understanding of fundamental AI concepts like automata, intelligent agents, graphs, and data structures.
Data Literacy	Ability to interpret, analyze, and use data effectively, particularly in AI-related contexts.
Ethical and Social Awareness	Knowledge of ethical considerations in AI, including transparency, fairness, and accountability.
Critical Thinking	Capability to critically evaluate AI technologies and their societal and ethical implications.
Pedagogical Competencies	Familiarity with educational strategies such as project-based learning to promote AI literacy.

Application of AI	Practical skills in applying AI in real-world settings, including fields like education, healthcare, and beyond.
Legal and Ethical Knowledge	Understanding the legal framework and ethical issues associated with AI usage.

Table 6 presents the identified competencies for AI literacy according to Ng et al. In all the reviewed articles, the ability to communicate knowledge about AI was emphasized (Ng et al. 2023: 4).

Balbo di Vinadio et al. specifically investigated competency requirements for public administration, which they integrated into a competency model. The competency model includes three areas, each with underlying competencies (see Table...):

- Digital Planning and Design
- Data Use and Governance
- Digital Management and Execution (Balbo di Vinadio et al. 2022: 13-16).

Table 7: AI Competencies in Public Administration according to Balbo di Vinadio et al.

Competency Area	Competencies
Digital Planning and Design	<ul style="list-style-type: none"> • Identification of problems where digital systems could contribute to the solution • System thinking • Strategic foresight • Agile planning
Data Use and Governance	<ul style="list-style-type: none"> • Digital Literacy • Data Driven decision making • Open data and open government (capacity to effectively create and use open data) • Privacy and security (knowledge of potential breaches and how they can affect government and society) • Legal, regulatory and ethical frameworks (capacity to adapt and change existing legislation to new technologies) • Basic understanding of AI systems
Digital Management and Execution	<ul style="list-style-type: none"> • People centricity • Iterative and agile project management • Digital Leadership

Table 7 presents the identified AI-related competencies in public administration according to Balbo di Vinadio et al. The study focused on countries in the Global South (Balbo di Vinadio et al. 2022: 13-16).

CONCLUSION

The increasing prevalence of AI technologies in the workplace necessitates continuous and systematic competency development. Both technical and social skills are crucial to meeting the demands of the future. Notably, there is a growing need for problem-solving, reflective, and communication competencies, as well as competencies for applying agile working methods. The extent to which current competencies may lose relevance due to the application of AI must be further investigated in future studies.

REFERENCES

1. Abdelkafi, N., Döbel, I., Drzewiecki, J., Meironke, A., Niekler, A., & Ries, S. (2019). Künstliche Intelligenz (KI) im Unternehmenskontext. [online] Available at: <https://publica.fraunhofer.de/entities/publication/ce4d6c03-0e63-4709-9dcf-0ea25058442e>.
2. André, E., Aurich, J.C., Bauer, W., Bullinger-Hoffmann, A., Heister, M., Huchler, N., Neuburger, R., Peissner, M., Stich, A., Suchy, O., Ramin, P., & Wächter, M. (2021). Kompetenzentwicklung für Künstliche Intelligenz – Veränderungen, Bedarfe und Handlungsoptionen. [online] Available at: https://doi.org/10.48669/pls_2021-2.
3. Balbo di Vinadio, T. Van Noordt, C., Vargas Alvarez del Castillo, C., Avila, R. (2022). Artificial Intelligence and Digital Transformation: Competencies for Civil Servants. [online] Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000383325>.
4. Baumgartner, M., Horvat, D., & Kinkel, S. (2023). Künstliche Intelligenz in der Arbeitswelt – Eine Analyse der Kompetenzbedarfe auf Unternehmensebene. [online] Available at: <https://kompetenzzentrum-karl.de/baumgartner-horvat-et-al-2023-kuenstliche-intelligenz-in-der-arbeitswelt/>.

5. Berninger-Schäfer, E. (2020). Digital Leadership. Bonn: Manager Seminare.
6. Bitkom. (2017). Künstliche Intelligenz. [online] Available at: https://www.dfki.de/fileadmin/user_upload/import/9744_171012-KI-Gipfelpapier-online.pdf.
7. Daniels, U.-D., Lindner, M., Sommer, S., & Rauch, E. (2023). AICOMP - Future Skills in a World Increasingly Shaped By AI. Ubiquity Proceedings, 3(1), 230-239. DOI: <https://doi.org/10.5334/uproc.91>.
8. Destatis. (2023). Nutzung von Künstlicher Intelligenz in Unternehmen 2023. Wiesbaden: Statistisches Bundesamt. [online] Available at: https://www.destatis.de/DE/Presse/Pressemitteilungen/2023/11/PD23_453_52911.html.
9. Dukino, C., Friedrich, M., Ganz, W., Hämmerle, M., Kötter, F., Meiren, T., Neuhüttler, J., Renner, T., Schuler, S., & Zaiser, H. (2019). Künstliche Intelligenz in der Unternehmenspraxis. Fraunhofer Verlag. [online] Available at: <https://publica.fraunhofer.de/bitstreams/0dd40c4f-9c68-4f8e-ba56-e4743834805d/download>.
10. Economic Forum. (2023). The Future of Jobs Report 2023. [online] Available at: <https://www.weforum.org/publications/the-future-of-jobs-report-2023/>.
11. Hasenbein, T. (2023). Die Transformation der Arbeitswelt durch Künstliche Intelligenz. München: Hanser Verlag.
12. Hofmann, J., Ricci, C., Schwarz, R., & Wienken, V. (2020). Erfolgskriterien betrieblicher Digitalisierung. [online] Available at: <https://www.iao.fraunhofer.de/content/dam/iao/images/iao-news/studie-betriebliche-digitalisierung-iao-bertelsmann.pdf>.
13. Kauffeld, S., & Paulsen, F. (2018). Kompetenzen im Zeitalter der Digitalisierung. Wiesbaden: Springer Gabler.
14. Long, D., & Magerko, B. (2020). What is AI Literacy? Competencies and Design Considerations. [online] Available at: <https://aiunplugged.lmc.gatech.edu/wp-content/uploads/sites/36/2020/08/CHI-2020-AI-Literacy-Paper-Camera-Ready.pdf>.
15. Ludwig, T., Azabal, N., Fries, M., Nießner, J., Elsholz, U., Lützenkirchen, S., Thomas, M., & Schröder, L. (2023). KI-Kompetenzen in der Praxis.

Eine Analyse deutscher KMUs. HMD Praxis der Wirtschaftsinformatik, 61, 202-214.
Available at: <https://doi.org/10.1365/s40702-023-01035-2>.

16. McKinsey, 2024. A new future of work: The race to deploy AI and raise skills in Europe and beyond. [online] Available at: <https://www.mckinsey.com/mgi/our-research/a-new-future-of-work-the-race-to-deploy-ai-and-raise-skills-in-europe-and-beyond#/>

17. Ng, D.T.K., Leung, J.K.L., Chu, S.K.W., & Qiao, M.S. (2021). Conceptualizing AI literacy: An exploratory review. Computers and Education: Artificial Intelligence, 2, p.100041. Available at: <https://doi.org/10.1016/j.caeai.2021.100041>.

18. Onnen, Arno, AI and Future Skills - An Integrative Competency Model (2024). Available at SSRN: <https://ssrn.com/abstract=4936939>.

19. Plattform Industrie 4.0. (2021). Technologieszenario „Künstliche Intelligenz in der Industrie 4.0“. [online] Available at: <https://www.plattform-i40.de/IP/Redaktion/DE/Downloads/Publikation/KI-industrie-40.html>.

20. Stowasser, S., & Suchy, O. (2020). Einführung von KI-Systemen in Unternehmen. [online] Available at: https://www.plattform-lernende-systeme.de/files/Downloads/Publikationen/Zusammenfassungen/AG2_Change_Management_Paper_Kurzfassung.pdf.

21. Sūna, L., & Hoffmann, D. (2021). Künstliche Intelligenz und KI-bezogene Kompetenzen. Ein Forschungsüberblick. [online] Available at: <https://digid.jff.de/auswertung-ki-kompetenzen>.

22. Teuber, K., Dindarian, A., & Cilo-van Norel Ekatarina, N. (2022). Künstliche Intelligenz und ihre Anforderungen an den Kompetenzerwerb. In Knackstedt, R. et al. (Eds.), Kompetenzmodelle für den Digitalen Wandel. Berlin: Springer.

23. von See, B. (2019). Ein Handlungsrahmen für die digitale Transformation in Wertschöpfungsnetzwerken. [online] Available at: https://tore.tuhh.de/bitstream/11420/3831/1/Dissertation_BvonSee.pdf.

Arno Onnen

University of Library Studies and Information Technologies

Sofia, Bulgaria

E-mail: arno.onnen@gmail.com