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AICOMP - FUTURE SKILLS IN A WORLD INCREASINGLY SHAPED BY AI

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Abstract

Globalisation and modernisation are creating an increasingly diverse and interconnected world. To make sense of and function well in this world, individuals need, for example, to master changing technologies and to make sense of large amounts of available information. They also face collective challenges as societies - such as balancing economic growth with environmental sustainability, and prosperity with social equity. In these contexts, the competences that individuals need to meet their goals have become more complex, requiring more than the mastery of certain narrowly defined skills.

Keywords:

Artificial Intelligence, Future Skills, AI-Competence

1. Introduction

The development of artificial intelligence (AI) is already having a massive impact on the world of work and daily life. The automation of processes and the optimisation of systems through the use of AI technologies are leading to constant change and new demands on people. Already today, certain competences are particularly in demand in order to be able to act successfully in a world shaped by artificial intelligence. These include, for example, the ability to collaborate with AI systems (distributed cognition) in creative problem solving or the ability to analyse and interpret large amounts of data.

The question of which competences are needed in a living and working world that is influenced by artificial intelligence to be able to act in both private and professional contexts is one of the most important questions in various fields of science. In order to answer this question we have conducted several research steps and have now constructed an initial competence framework which we call "AIComp" (Acronym: Artificial Intelligence Competences).

The aim of this study is to process the currently available scientific work on AI-related competences, create a synopsis of competence requirements and bundle them in form of AI-related "Future Skills-Profiles", which serve as larger and overarching competence fields. They each contain knowledge-, skills- and value-related requirements that are important for successful actions in a world permeated by AI.

This paper follows a four step flow: In the first part (section 2), the State of the art research literature on AI literacy and competence is analysed and classified. In the next part (section 3), a methodology for qualitative meta-studies is described. A six-step research-, analysis- and design process is described step-by-step, leading into the design of the AIComp model in section four. This is presented in overview and fully presented in the appendix online.

2. Which competences for AI?

We base our work on the consideration that AI needs to serve individuals and society to freely and actively develop in a changing world. Our ambition is to cover competences for both economic and social purposes. This is rooted in an understanding of human capital in a wide sense including social-, educational- and economic capital (Bourdieu 1983). We strive to identify competences of behavioural nature that follow the underlying concept of "action competence" (Ehlers 2020) which we call "Future Skills" and which support individuals to act

successfully in AI-related contexts in their professional and private lives. Thus, we strive to identify AI-related Future Skills which are important for a broad range of individuals, instead of focussing those competences that are of use only in a specific trade, occupation or walk of life.

In the international literature, the so-called "KSAVE model" has become established for the operationalisation of action competences (Binkley et al. 2012). It provides that action competences are constituted by the three dimensions already mentioned above: Knowledge - Skills - Attitudes/Values/Ethics (see fig. 1).

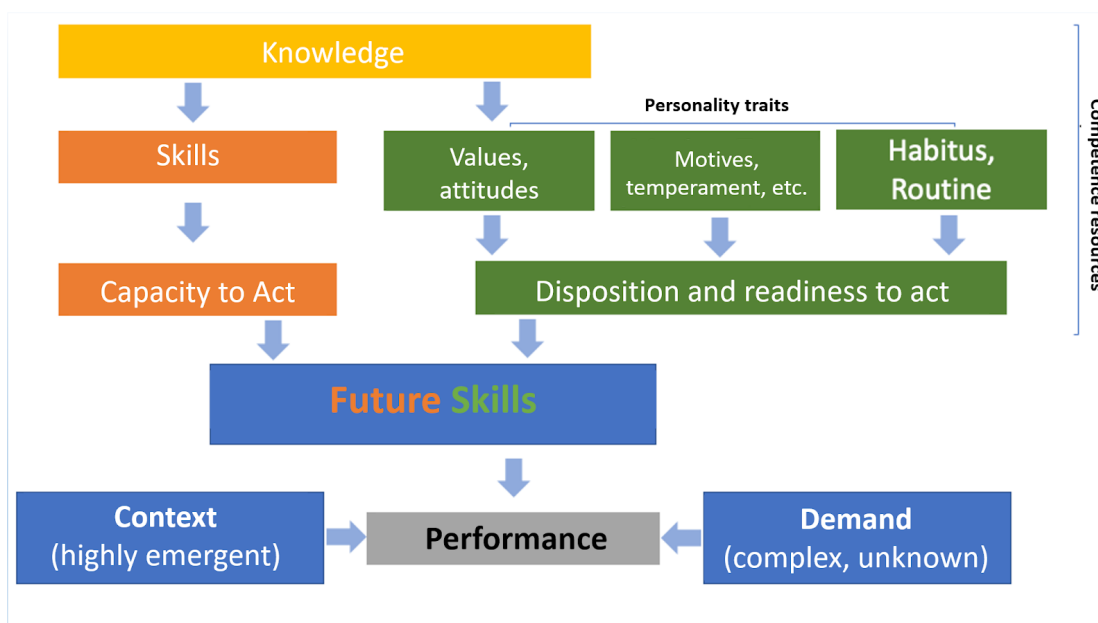


Fig. 1: Competence structure model for Future Skills (Ehlers 2020)

For the competence model "AIComp", we also chose this three-part competence structure for each AI-related Future Skill-Profiles. In addition we formulated larger clusters in which we group Future Skills profiles which are called "areas of action". Overall, this results in the following structure:

- Areas of action, which contain
- AI-related Future Skills Profiles, which include
- Knowledge (K) + Skills (S) + Attitudes(A)

Interim conclusion: Requirements for an AI skills framework

In conclusion, it appears that AI-related competence as an action competence model is not yet sufficiently elaborated and represents a research gap. With the present research overview, we intend to take a first step, based on the existing literature, to establish an action competence-oriented framework. As a first definition of AI-related competences we propose: Future Skills for a lifeworld that is increasingly shaped by AI is the ability to successfully act in emergent and complex situations. The framework concept should fulfil the following functions in particular:

1. systematise already empirically based and/or analytically derived competences and competence requirements and relate them into a model based on KSAVE components and action competence,
2. make visible competence requirements that are placed on certain groups.

3. AI-Related Competences: A Qualitative Meta-analysis

In this chapter we give an overview of the step-by-step process we used to analyse existing AI-related competence frameworks. We are then going to present our aggregated new AI-related competence framework.

3.1 On the Methodology of Qualitative Meta-analysis

A qualitative meta-analysis is a systematic summary of empirical studies using the instrument of qualitative content analysis (Timulak 2009). It serves to find (meaning) structures, concepts and constructs in the present study on the topic of AI competences. We proceed in the following steps:

Research and analysis stage

1. Research: Keyword-based search in search engines on the topic of AI-related competence approaches as well as lists of skills and descriptions.
2. AIComp I: Create a unified list of skills and competences and their descriptions.
3. AIComp II: Cleaning the data by expanding multidimensional formulations into one-dimensional ones as well as paraphrasing and deleting duplicate mentions.
4. AIComp III: Synthesis and grouping based on four content dimensions: Knowledge Assets, Application Skills, Creative Skills and Innovation, and Critical Analysis, Reflection and Ethics. Further paraphrasing to increase concept clarity. Finally, mapping of K-S-A where possible.

Design stage

5. AIComp IV: Mapping of the individual skills to the Future Skills-Profiles. The result is competence descriptions for individual competence profiles, which are operationalised by K-S-A in each case.
6. AIComp qualitative final: Recontextualisation of the competence descriptions into a final qualitative model of AIComp.

3.2 Research and Analysis Stage

In the following section, we describe the meta-analysis and the research steps carried out for this purpose.

Step 1: Research

The research phase pursued the goal of collecting international research papers in German or English on the topic of AI-related competences from the period of the years 2019 to 2023. The following keywords were used for the search:

- Artificial intelligence, or AI for short
- AI competence and AI competence framework
- AI Skills, AI Abilities
- AI Learning, AI Education, AI Training
- KI Learning objectives

The focus of the search was on elaborated competence frameworks and lists of competence elements for non-technical learners. Furthermore, publications that explicitly deal with the concepts of AI literacy or AI competence but do not contain lists or frameworks themselves were classified as relevant. (see Table 1).

Table 1: Competence/Literacy approaches for AI-related competences

No.	Title	Author	Year	Education sector
1	A.I. and Digital Transformation. Competencies for Civil Servants	UNESCO Broadband Commission	2022	VET
2	What is AI Literacy? Competencies and Design Consideration	Long, Magerko	2020	not specified
3	EU DigComp 2.2: The Digital Competence Framework for Citizens	Vuorikari, Kluzer, Punie (EU)	2022	Life-long learning
4a	Competences for AI. Changes, needs, options for action	André et al.	2022	VET
4b	AI competence development in material and production work. Micro study (project report)	André et al.	2022	VET
5a	AI Literacy: Competence dimensions and influencing factors in the context of work	Wienrich, Carolus et al.	2022	VET

5b	MAILS - Meta AI Literacy Scale: Development and Testing of an AI Literacy. Questionnaire Based on Well-Founded Competency Models and Psychological Change- and Meta-Competencies	Carolus et al.	2022	VET
6	Delphi study for the development and preliminary validation of an item set for the assessment of non-experts' AI literacy	Laupichler et al.	2023	not specified
7	AI Literacy: Definition, Teaching, Evaluation and Ethical Issues	Ng, Leung et al.	2021	not specified
8	AI Skills. A Preliminary Assessment of the Skills Needed for the Deployment, Management and Regulation of Artificial Intelligence. 2022	National Skills Council (Ireland)	2022	not specified
9	Artificial Intelligence Competency Framework. A success pipeline from college to university and beyond.	Blok, Trudeau, Cassidy	2021	higher education
10	Necessary competences for administrative staff in dealing with AI - Practice-related competence grid	Catakli/Punt Shoe	(2023, in progress)	VET
11	Artificial intelligence and AI-related skills. A research overview.	Sūna/Hoffmann (currently in preparation)	2021 (in progress)	not specified

Step 2: Creating a unified list of skills and competences and their descriptions

In an inventory, all formulations of competence inventory items related to AI were then listed. In this way, a total of 167 competence items of different types, lengths and complexity could be listed in an inventory.

Step 3: Data cleaning, expanding multidimensional formulations, paraphrasing and deleting duplicate items

A further version was then created using qualitative content analysis procedures. For this purpose, all formulations of competence inventory items that were included twice were removed (115 mentions). Then the formulations were checked for their dimensionality. In this process, those formulations that contained several aspects or dimensions in one item were broken down into their parts and checked to see whether these were already contained in other formulations. New aspects were included as paraphrased formulations. In a further step, all formulations were paraphrased and adapted to a common linguistic style, while retaining the content-related aspects. The result was 34 individual formulations of competence inventory items.

Step 4: Synthesis and grouping based on four content dimensions

The competence was now analysed and allocated to a literacy model for media literacy in order to check to what extent they contained balanced dimensions according to the model (see Baacke 1997). These dimensions included: knowledge assets (13), application skills (5), creative skills and innovation (6) and ability for critical analysis, reflection and ethics (10).

Marginal wording changes were made to sharpen the clarity of the concept.

In addition, all these collected competence inventory items were roughly assigned to the competence dimensions: Knowledge (19) - Skills (18) - Attitudes (26).

3.3 Design Stage: Design of the AIComp Model

The design of the initial AIComp model into a Future Skills-structure for AI took two further steps. A three-level structure was used as guiding concept. At the level one, this consists of items from the competence inventory that describe knowledge, skill descriptions or attitudes. At level two these are summarised into AI-related Future Skills-profiles. At level three, the Future Skills-profiles are divided into three areas of action:

- those that relate more to personal competences,
- those that relate to competences that enable creative use of AI technologies, applications or concepts,

- those that contain the necessary competences to master the changes in organisations, communication and cooperation structures resulting from AI.

Step 5: *AIComp* - Mapping the individual skills to the Future Skills-profiles. The result is competence descriptions for individual competence profiles, each of which is operationalised by K-S-A.

First of all, 13 AI-related Future Skills-profiles were developed from the Future Skills-profiles of the NextSkills-study and on the basis of the inventory of 167 AI-related skills determined qualitatively in the state of research. These include those competences that are required when the corresponding Future Skills-profile is related to AI-infused living and working environments. The qualitative inventory items assigned to each of these competences answer the question of which knowledge, which skills and which attitudes are considered necessary in order to be able to act successfully within this framework.

Step 6: *AIComp* qualitative final recontextualisation of the competence descriptions into a final qualitative model of *AIComp*

In the last step of the process, the formulations of the Future Skills-profiles are made more precise on the basis of the existing inventory items. As a result, the qualitative inventory currently contains 67 AI-related items that are grouped into 13 Future Skills-profiles.

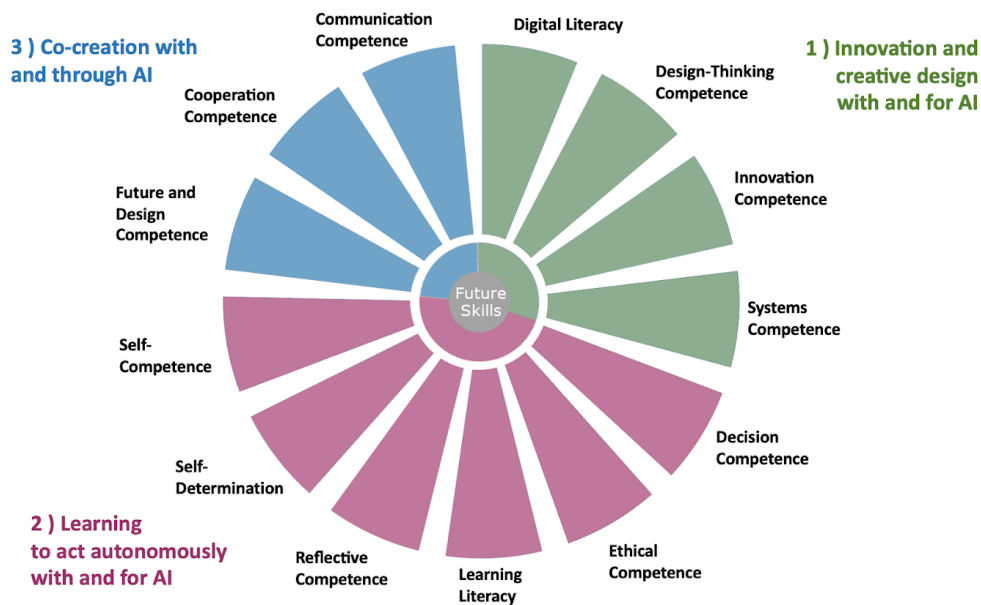


Fig. 2: AI-related Competences (Ehlers, Lindner, Sommer, Rauch 2023)

Table 2: Description of AI-related competences

Area 1: Innovation and creative design with and for AI Competences to use AI technologies and applications as an object and/or method, to develop them further or to develop solutions and concepts in connection with AI for concrete tasks and for organisationally or individually significant contexts of action.	
I – Digital competence	Being able to utilise AI tools and apps, to develop them in a productive way, to leverage them for one's own purposes; and to reflectively, critically and analytically comprehend their technical modes of action in relation to the individual and society as a whole, including knowledge of the potentials and limits of AI and its modes of action.
I.1	Being able to thoroughly evaluate and analyse the implications of the technological inner logic of AI systems based on their impact on organisations or society.
I.2	Being able to evaluate, analyse and make sense of AI technologies and applications regarding their functions and the benefits of their application.

I.3	Being able to assess and analyse the influence of AI technologies on the handling of data.
II. Design thinking competence	Being able to employ concrete methods and techniques for realising creative development processes dealing with problems and issues related to AI in a way in way that is open ended and involving all stakeholders in a collaborative process for problem-solving and solution design.
III. Innovation competence	Being willing to advance AI innovation within organisations as a subject and as a theme as well as in processes, and to incorporate AI into organisational innovation ecosystems.
IV. System competence	Being able to comprehend AI tools and AI concepts as embedded within complex personal-psychological, social and technical systems, as well as identifying and grasping their mutual effects, and being able to design and/or accompany coordinated planning and implementation processes for new projects within a given system.
IV.1	Being able to perceive and analyse AI systems from the perspective of integrating them in a larger social system (of an organisation, of society).
IV.2	Being able to consider AI technologies and applications from the perspective of system architecture and system design, and to derive appropriate actions based on this.
<p>Area 2: Learning to act autonomously with and for AI</p> <p>Competences necessary to act as an individual in a sovereign and responsible manner in an AI-permeated world and to use AI concepts and tools for one's own objectives in a responsible, productive and reflective way.</p>	
I. Decision-making competence	Being able to recognise the need for decisions in AI-related situations and to evaluate alternative choices to make a decision and take responsibility for it.
II. Ethical competence	Being able to perceive AI-related issues as ethically relevant (perception), to formulate and test premises in relation to AI-relevant issues (evaluation) as well as the ability to test the application conditions of AI-related conceptions and their alternatives (judgement).
III. Learning competence	Being open, able and willing to learn about AI issues and through the use of AI tools and applications.
IV. Reflection competence	Being able and willing to recognise the underlying behaviours, thought systems and value systems related to topics connected with AI, and to holistically assess how they inform actions and decisions.
V. Self-determination	Being able to act productively in the tension between external determination and self-determination brought about by data and AI algorithms, and to create self-determined spaces for one's own needs-oriented development.
VI. Self-competence	Being able to use AI tools to support one's own personal and professional development, and to deal with self-organisation, time management as well as cognitive load management with a high degree of personal responsibility when using AI tools.

<p>Area 3: Co-creation with and through AI</p> <p>Competences that support the ability to act in relation to AI-issues affecting the social, organisational and institutional environment. These include, for example, the ability to design alternative "AI futures", to help shapingshape the social impact of AI in a critical and reflective manner, to work and cooperate with others, and to communicate, criticise and reach consensus in manners appropriate to a specific situation, also in intercultural contexts.</p>	
I. Future and design competence	Being open, courageous and creative to embrace the new; being willing to change and to look forward in order to further develop and transform existing AI-related concepts in the direction of new, unprecedented visions of the future.
II. Cooperation competence	Being able to work in interdisciplinary and interorganisational teams on projects and plans relating to AI, also across cultures, to overcome existing differences and find common ground.
III. Communication competence	Having discourse, dialogue and strategic communication skills, in order to being able to communicate successfully relating to AI subjects in different contexts, in a situationally appropriate manner.

Conclusions

This paper summarises the interim results of a work in progress that aims at systematically developing a Future Skills framework, suited for helping individuals, organisations and educational institutions to build the action-oriented competences needed for a future world that will be permeated by AI on all levels, in all fields of private and working life.

Six different lists of all in all 160 granular competence inventory items, representing elements of holistic competences, were identified, analysed, evaluated and set in relation. From this pool relevant elements were selected and included in a set of Future Skills-Profiles, thus creating a context in which the separate, more granular concepts of "skills", "competences" and "literacies" of workers, students, citizens and consumers become recognizable as part of one big picture.

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