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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 focusing 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)](image)

For the competence model "AlComp", 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 fulfill 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. AlComp I: Create a unified list of skills and competences and their descriptions.
3. AlComp II: Cleaning the data by expanding multidimensional formulations into one-dimensional ones as well as paraphrasing and deleting duplicate mentions.
4. AlComp 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. AlComp 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. AlComp qualitative final: Recontextualisation of the competence descriptions into a final qualitative model of AlComp.

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

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Author</th>
<th>Year</th>
<th>Education sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A.I. and Digital Transformation. Competencies for Civil Servants</td>
<td>UNESCO Broadband Commission</td>
<td>2022</td>
<td>VET</td>
</tr>
<tr>
<td>2</td>
<td>What is AI Literacy? Competencies and Design Consideration</td>
<td>Long, Magerko</td>
<td>2020</td>
<td>not specified</td>
</tr>
<tr>
<td>3</td>
<td>EU DigComp 2.2: The Digital Competence Framework for Citizens</td>
<td>Vuorikari, Kluzer, Punie (EU)</td>
<td>2022</td>
<td>Life-long learning</td>
</tr>
<tr>
<td>4a</td>
<td>Competences for AI. Changes, needs, options for action</td>
<td>André et al.</td>
<td>2022</td>
<td>VET</td>
</tr>
<tr>
<td>4b</td>
<td>AI competence development in material and production work. Micro study (project report)</td>
<td>André et al.</td>
<td>2022</td>
<td>VET</td>
</tr>
<tr>
<td>5a</td>
<td>AI Literacy: Competence dimensions and influencing factors in the context of work</td>
<td>Wienrich, Carolus et al.</td>
<td>2022</td>
<td>VET</td>
</tr>
<tr>
<td></td>
<td>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</td>
<td>Carolus et al.</td>
<td>2022</td>
<td>VET</td>
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<tr>
<td>6</td>
<td>Delphi study for the development and preliminary validation of an item set for the assessment of non-experts’ AI literacy</td>
<td>Laupichler et al.</td>
<td>2023</td>
<td>not specified</td>
</tr>
<tr>
<td>7</td>
<td>AI Literacy: Definition, Teaching, Evaluation and Ethical Issues</td>
<td>Ng, Leung et al.</td>
<td>2021</td>
<td>not specified</td>
</tr>
<tr>
<td>8</td>
<td>AI Skills. A Preliminary Assessment of the Skills Needed for the Deployment, Management and Regulation of Artificial Intelligence. 2022</td>
<td>National Skills Council (Ireland)</td>
<td>2022</td>
<td>not specified</td>
</tr>
<tr>
<td>9</td>
<td>Artificial Intelligence Competency Framework. A success pipeline from college to university and beyond.</td>
<td>Blok, Trudeau, Cassidy</td>
<td>2021</td>
<td>higher education</td>
</tr>
<tr>
<td>10</td>
<td>Necessary competences for administrative staff in dealing with AI - Practice-related competence grid</td>
<td>Catakli/Punt Shoe</td>
<td>(2023, in progress)</td>
<td>VET</td>
</tr>
<tr>
<td>11</td>
<td>Artificial intelligence and AI-related skills. A research overview.</td>
<td>Sūna/Hoffmann (currently in preparation)</td>
<td>(2021, in progress)</td>
<td>not specified</td>
</tr>
</tbody>
</table>

**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 AlComp Model

The design of the initial AlComp 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: AlComp - 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 Al-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: AlComp qualitative final recontextualisation of the competence descriptions into a final qualitative model of AlComp**

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.

![Diagram of Al-related Competences](image)

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

<table>
<thead>
<tr>
<th>Table 2: Description of Al-related competences</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Area 1: Innovation and creative design with and for AI</strong></td>
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<tr>
<td><strong>1 – Digital competence</strong></td>
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<tr>
<td>1.1</td>
</tr>
<tr>
<td>1.2</td>
</tr>
<tr>
<td>Area: AI</td>
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<tr>
<td>I.3</td>
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<tr>
<td>II. Design thinking competence</td>
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<td>III. Innovation competence</td>
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<td>IV. System competence</td>
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<tr>
<td>IV.1</td>
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<tr>
<td>IV.2</td>
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<tr>
<td>Area 2: Learning to act autonomously with and for AI</td>
</tr>
<tr>
<td>I. Decision-making competence</td>
</tr>
<tr>
<td>II. Ethical competence</td>
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<tr>
<td>III. Learning competence</td>
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<tr>
<td>IV. Reflection competence</td>
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<tr>
<td>V. Self-determination</td>
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</tbody>
</table>
Area 3: Co-creation with and through AI
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 shape 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.

<table>
<thead>
<tr>
<th>I. Future and design competence</th>
<th>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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>II. Cooperation competence</td>
<td>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.</td>
</tr>
<tr>
<td>III. Communication competence</td>
<td>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.</td>
</tr>
</tbody>
</table>

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.

References


