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# COMPETENCE MAPS AS A COMMON LANGUAGE BETWEEN TRAINING INSTITUTIONS AND COMPANIES TO MANAGE RECRUITMENT ISSUES

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## Abstract

In today's fast-paced and competitive business environment, companies face mounting pressure to sustain their market positions while navigating a complex recruitment landscape. This landscape is characterized by several challenges in terms of human resources, including labor shortages, high turnover rates, intense competition in manufacturing industries such as bar turning and unsuitable candidate profiles particularly in certain jobs that lack adequate training.

To effectively address the latter challenge, it is crucial for companies to adopt an active approach to improving the profile of candidates to match their needs. Competence-based approach has emerged as an essential means in this endeavor to equip their future candidates with the necessary competences. Employee competence representation (e.g. competence maps) is crucial to define the adequate training program. These maps serve as a visual representation of the competences required within professional situations. They are considered as a structured framework that highlights the components of situations: actors, activities, objectives, resources, performances, schemes and actions. Based on these components, it is possible to establish a training program following the competence-based approach. A specific tool, called CaTCaP and developed in our research laboratory, allows to build these competence maps to establish a common language between training institutions and companies.

As an example, in the field of batteries, industrial companies have identified a growing need for technicians. The rapid advancements in battery technology and the increasing demand for energy storage solutions have highlighted a significant competence gap in this sector. For instance, Verkor a company involved in battery manufacturing, whose ambition is to increase the production of low-carbon batteries to meet the growing demand for electric vehicles, have explicitly stated their need for well-trained battery technicians to support their operations and growth. To meet this demand, the Ecole Nationale Supérieure des Arts et Métiers (ENSAM) has developed a new specialized bachelor's degree course. This program aims to equip students with the competences needed to meet the specific needs of companies in the battery sector. By offering this targeted training, the school aims to facilitate their recruitment of the graduates and prepare them for successful careers. This initiative not only addresses the current competence gap but also supports companies struggling to find adequately trained professionals.

Within this framework, competences maps play an important role in representing the required competences in order to build the training program provided by the school. These maps serve as a visual and descriptive representation of clearly defining and communicating the specific competences essential for battery technicians. They help to identify the learning and assessment situations to achieve a constructive alignment of teaching and learning. This article aims to explore how, by starting from a real industry need, a training program can be built to meet the recruitment challenges that some professionals face today with regard to inadequate candidate profiles.

Keywords: Initial training, Competence-based approach, KSA components, Competence development, Training program, Competence map.

## 1 INTRODUCTION

In today's rapidly evolving market, the importance of competence has become increasingly apparent, particularly in industries that rely heavily on specialized expertise. Notably, the manufacturing sector in France is encountering notable hurdles in recruitment, as underscored by a study featured in

“Economics & Statistics” by INSEE<sup>1</sup>. Collaboratively conducted with the “Banque de France” in September 2019, this study presents the underlying causes and implications of recruitment challenges confronting French enterprises. The study delineates a concerning trend: the prevalence of recruitment issues in France has been steadily increasing since mid-2015, particularly within the industrial domain. By the end of 2019, nearly half of the industrial enterprises reported concerns about recruitment. These challenges emanate from various factors, which can be broadly categorized into four main areas ([1],[2],[3]).

Firstly, the labor shortage indicator portrays a critical issue, with companies expressing their inability to fully develop their operations due a dearth of personnel. Regions like the Arve Valley in the French Alps have prominently identified this issue ([5],[6]). Secondly, turnover emerges as a persistent problem for organizations across sectors, driven by competition and evolving market dynamics ([7],[9]).

Thirdly, the highly competitive industrial environment, especially within manufacturing sectors, presents additional recruitment complexities ([10],[11],[12]). Lastly, unsuitable profiles particularly in certain jobs that lack adequate training pose significant recruitment hurdles, cited as one of the most challenging aspects for companies both domestically and internationally ([13]).

To respond adequately to the latter challenge, it is essential that companies take a proactive approach to enhancing these profiles to meet their needs. A competence-based approach has proved essential in this effort to equip future candidates with the necessary competences. In the ever-changing landscape of today’s market, the significance of competence has come to the forefront, especially within the context of human-centered industry ([4]). Hence, the representation of employee competences, for example, through competence maps, is fundamental to defining an appropriate training program. These maps serve as a visual representation of the competences required in professional situations. A dedicated tool, named CaTCaP (Ref. ANR-18-CE10-0011/<https://catcap.univ-smb.fr/>) and developed in our research laboratory, can be used to build these competence maps in order to establish a common language between training institutions and companies ([14],[15],[16]).

For instance, in the battery sector, industrial companies have identified a growing need for technicians. Rapid advances in battery technology and growing demand for energy storage solutions have highlighted a significant competences gap in this sector. As an example, Verkor, a company in battery manufacturing, is aiming to increase production of low-carbon batteries to meet the growing demand for electric vehicles. It has explicitly expressed its need for well-trained battery technicians to support its operations and growth. To meet this demand, the Ecole Nationale Supérieure des Arts et Métiers (ENSAM) is starting to develop a new specialized bachelor’s degree program. The program is designed to equip students with the competences needed to respond to the specific needs for companies in the battery sector. By offering this targeted training, the ENSAM aims to facilitate the recruitment of its graduates and prepare them for a successful career. This initiative not only responds to the current competence shortage, but also supports companies struggling to find suitably trained professionals. In this context, competence maps play an important role in representing the competence required to build the training programs offered by educational establishments such as the ENSAM. These maps serve as a visual and descriptive representation to clearly define and communicate the specific competences essential for battery technicians.

This research is focused on the recognition of individual and collective competences. Our aim is to address the issue of making individual and collective competences on the basis of actual, contextualised human activity, which is at the heart of this theme. Our research question therefore revolves around the missing competences that companies identify and need to adapt to the changing demands of the sector, and how these missing competences can be integrated into training programs to better meet the needs of the organization. This article initiates by delving into the core principles of the competence-based approach, offering readers a comprehensive understanding of its foundational concepts. Following this exploration, it delves deeper into how competence is defined within organizational contexts and elucidates the process of creating competence maps. Lastly, the article demonstrates how to build training program based on actual industrial needs.

## **2 COMPETENCE BASED-APPROACH**

In the ever-evolving landscape of the contemporary workforce, developing a skilled workforce is paramount for organizational success. The competence-based approach emerges as a strategic

<sup>1</sup> INSEE: The National Institute for Statistics and Economic studies is a department of the ministry of Economic and Finance. Its mission is to collect, analyze and communicate information on the French economy and society throughout its territory.

framework that places training and competence development at its foundation, recognizing their pivotal role in shaping employee proficiency and organizational resilience. This strategy not only targets candidates in the job market but also focuses on the development of existing initiatives. Such a strategy aims to foster the progression of employees' careers by improving their competences and their motivation, thereby enhancing their potential within the organization. We first need to understand what this competence-based approach is all about.

## 2.1 Definition

The competence-based approach represents a paradigm shift in educational planning and delivery, tailored to facilitate the development of competences crucial for professional success. This innovative teaching method emphasizes formative and certificated assessments aimed at evaluating the broad spectrum of competences acquired through training programs. Competences, conceived as complex know-how, integrate a relatively vast set of resources: knowledge, skills, personal abilities, tools...([17],[18]). A gradual and progressive assimilation of these resources within authentic professional contexts, research endeavors, or civic engagements is needed. Thus, acting competently entails mastering the threefold process depicted in Figure 1.



Figure 1. Competence-based approach ([17]).

After defining the competence-based approach, delving deeper into the meaning of competence within business contexts becomes essential. Indeed, comprehending how competences are defined, assessed, and implemented within an organization is crucial for effective application of this approach. Therefore, we will now proceed to examine in detail the definition and significance of competences in a professional context, highlighting their central role in an organizational success ([19],[20]).

## 2.2 Defining competences inside companies

Knowing how companies define skills is an important input to our study. Indeed, this expression of competences directly influences talent management, organizational culture and strategic decisions. By focusing on these definitions, we can better understand how companies view and utilize competences to support their business goals and maintain a competitive edge. This involved conducting a thorough review of existing literature, leading to the creation of the description shown in Figure 2.

Drawing from a field study published by France Stratégie<sup>2</sup>, which involved interviewing managers and human resources representatives about their practices and perceptions of competences, we gained insights. These interviews were conducted face-to-face with HR managers and senior executives from fourteen companies ([21]).

<sup>2</sup> France Stratégie is a department of the Prime Minister, responsible for helping to determine the broad guidelines for the nation's future and the medium and long-term objectives for its economic, social, cultural and environmental development, as well as preparing reforms in France.

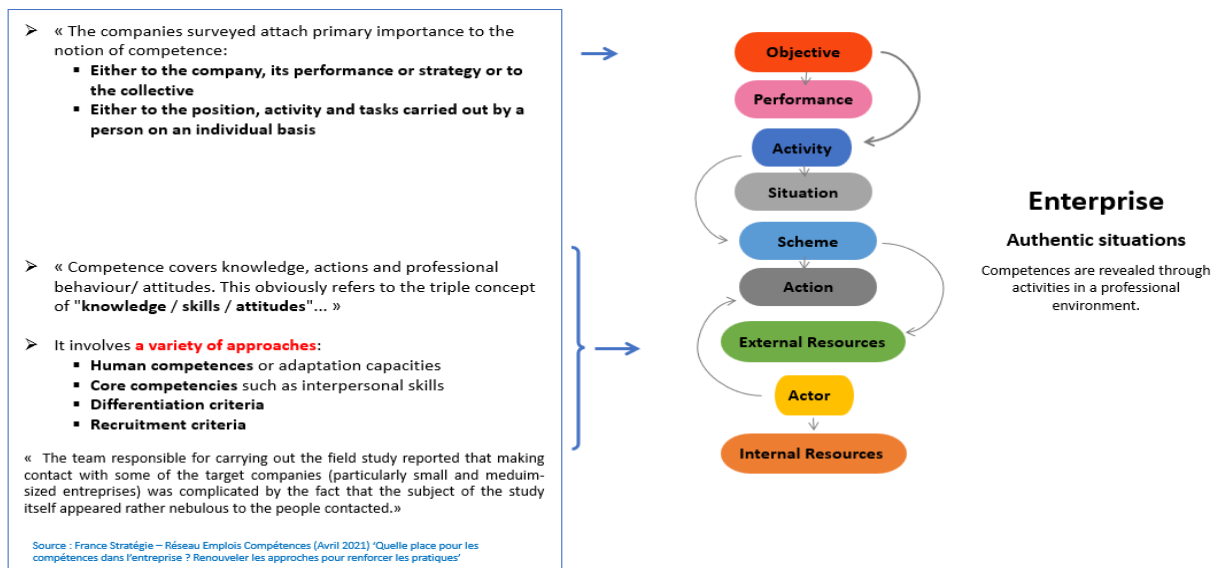


Figure 2. Company definition of competence.

Looking at Figure 2, several interpretations emerge:

- The majority of companies surveyed define competence in terms of its relevance to the company's activities, performance, or strategy. This is usually achieved by means of authentic situations that describe the environment in which the activity takes place. To carry out the activity in question, it is essential to put in place a sequence of actions which represents a scheme. This involves achieving a main objective with a certain performance that reflects the assessment of the final result of the activity.
- The companies interviewed provided a more detailed definition of competence, including internal employee resources (knowledge, skills, attitudes) within the company. This definition also encompasses various aspects such as human competences and differentiation criteria, which may rely on external resources.

The definition of competences established by companies lays the foundation for understanding the skills, knowledge and attitudes valued within the organization. However, translating these definitions into actionable frameworks requires a structured approach. The subsequent section will focus on elucidating the pivotal role of competence maps in this process.

## 2.3 Competence Map

A competence map serves as a visual guide depicting the specific skills, knowledge, and attributes essential for successful job performance. By presenting authentic situations and activities relevant to the job role, a competence map offers a structured overview of the competences needed to excel in various aspects of the job, serving as a comprehensive guide for individuals and organizations to understand and develop the necessary capabilities ([22],[23]).

For our study, the competence map is based on both static and dynamic models that have been established in a previous research work ([24]).

It is composed of the following components:

- Objective – It refers to the aim of the activity (or activities). It must be Specific, Measurable, Achievable, Relevant and Time-bound (SMART) ([25]).
- Performance – It describes the final result of an individual's activity in a specific position.
- Activity – It designated an organized combination of actions according to a specific scheme which are necessary in order to achieve the defined objective.
- Situation – It represents a description of the environment in which the activity takes place (e.g project, team, etc.), including the constraints required and the events encountered in carrying out the activity.

- Scheme – It describes the organization of the activity as a sequence of actions to carry it out.
- External resources or environmental resources – It consists of a specification of any external tools or equipment used during the activity (e.g. software, tool, etc.).
- Actor – It is a person who carries out some actions to achieve a particular objective in a specific activity.
- Internal resources or personal resources – It is a description of the knowledge, skills and attitudes potentially mobilized and combined during the activity.

To enhance the representation of the competence map, a prototype of a software tool named CaTCaP<sup>3</sup> (<https://catcap.univ-smb.fr/>) has been developed as part of a research project (Ref. ANR-18-CE10-0011). CaTCaP offers valuable functionalities tailored for teachers, students, researchers as well as business professionals. Figure 3 illustrates a typical example of a competence map created using this tool.

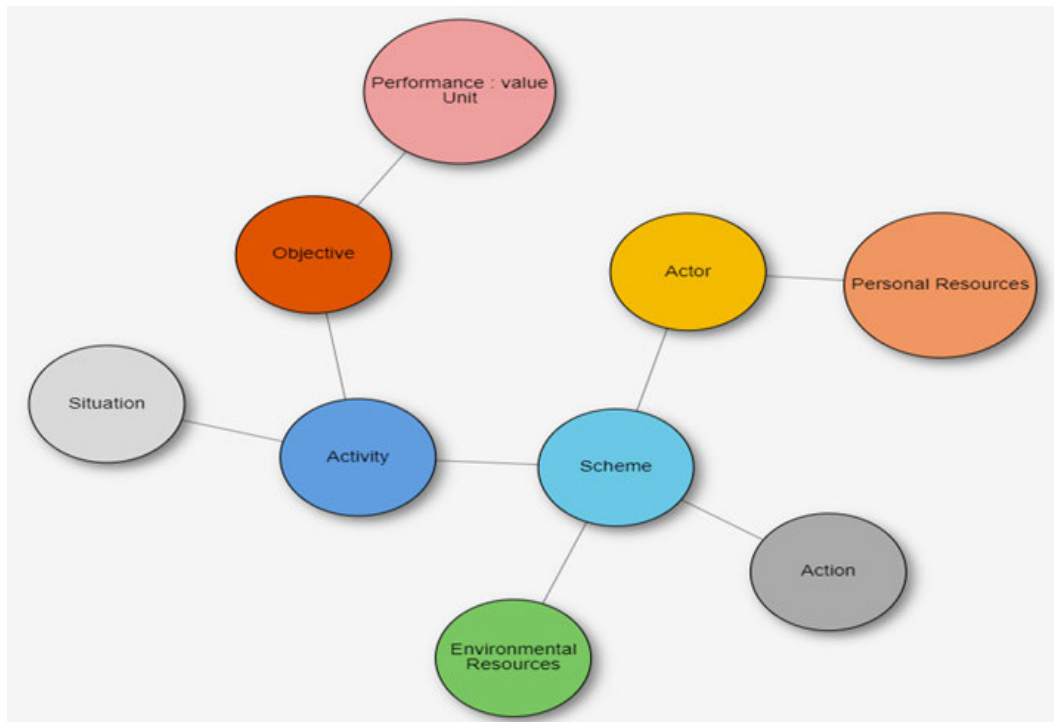


Figure 3. Competence map example using CaTCaP.

To construct a map, we initiate by establishing an “objective” node followed by a “performance” node and connecting them. Subsequently, we generate two additional nodes, denoted as “activity” and “situation” correspondingly. The “objective” and “situation” nodes are then attached to the “activity” node. Following this, we finalize the five remaining nodes: “scheme”, “action”, “external resources”, “actor”, and “internal resources”, and arrange them accordingly based on the connections depicted in Figure 3. This map-building process enables players to question their own practices and the competences they use.

The definition of competences established by companies lays the foundation for understanding competences valued within organizations. However, translating these definitions into actionable frameworks requires a structured approach. One effective tool for this purpose is the competence map, which visually represents the specific competences necessary for successful job performance. By clarifying these competences, organizations can better align training and development initiatives with real-world requirements.

In the following section, we will explore how competence maps play a vital role in the design of targeted training programs. Specifically, we will focus on their application in the battery industry, where rapidly evolving technological needs demand specialized competences to address current workforce needs.

<sup>3</sup> CaTCaP – Capture of the operational Traces of the company’s actors to build human Capital and define the winning Processes: it is an ANR (“National Research Agency” project, the aim of which is to extract the competences contained in the current practices and learning of the various members of the company, in order to be able to manage the company’s immaterial capital by enhancing and/or developing existing competences and to mobilise them intelligently by defining practices adapted to real skills.



### 3 DEVELOPING TARGETED TRAINING PROGRAMS BASED ON A REAL INDUSTRIAL NEED

The battery sector, where industrial companies have identified a growing need for technicians, serves a prime example. Rapid advances in battery technology and the increasing demand for energy storage solutions have highlighted a significant competence shortage in this industry. A comprehensive assessment of the competences required by this industry, as detailed in the 2022 report on future competences needs in the battery sector in France ([8]), revealed significant gaps, particularly in technical competences. The report identified critical areas of expertise, including battery assembly, maintenance, and recycling, as well as proficiency in handling the advanced automation and digital tools used in modern production lines. These findings underscored the need for robust training programs to develop these competences in response to growing industry demands.

Verkor, a leading battery manufacturer aiming to increase production of low-carbon batteries to meet the growing demand for electric vehicles, explicitly expressed its need for well-trained battery technicians to support its operations and expansion. The company's growth ambitions depend heavily on technicians competences in the operation of advanced manufacturing processes and the ability to ensure the safety and efficiency of production. In response to this identified gap, the École Nationale Supérieure des Arts et Métiers (ENSAM) is starting to develop a specialized bachelor's degree program designed to provide students with the competences needed to fulfill the specific requirements of companies in the battery industry. This includes core competences in manufacturing, assembling electrotechnical systems, operating machine tools, and using numerical control programs. Moreover, the program integrates essential knowledge in materials science, manufacturing processes and electrical safety standards, while also providing training in technical English to prepare students for the international dimensions of the industry.

The training is offered through an apprenticeship model that combines on-the-job learning with industrial employers and academic instruction at the ENSAM, ensuring that students gain practical experience alongside their theoretical studies.

Graduates of this program are thus prepared to meet the specific needs of the battery sector by bridging identified gaps in technical competences. One of these key competences, as identified in the 2022 report, is the ability to manufacture parts and assemblies according to precise specifications, ensuring quality and safety standards. This competence, along with its equivalent at the company level, will be represented using CaTCaP, as outlined in the second section and illustrated in Figure 4.

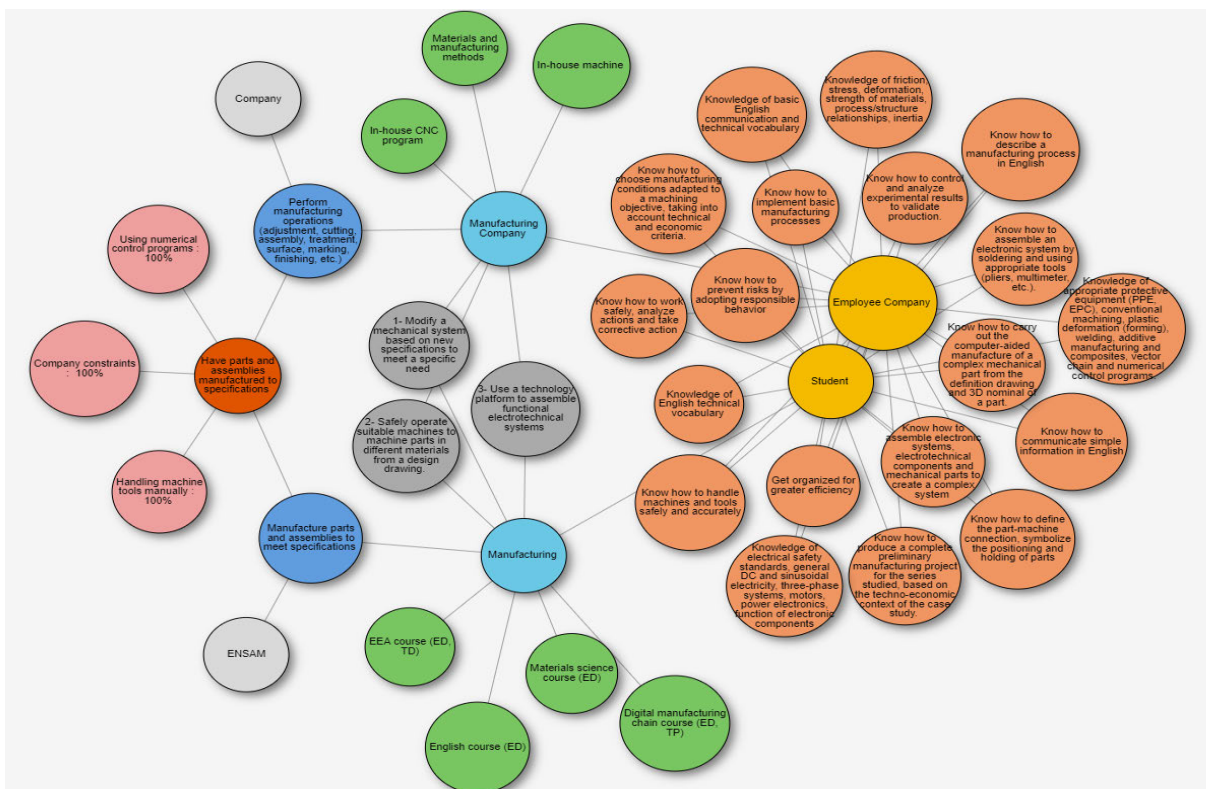


Figure 4. ENSAM / Company competence map.

The map given in Figure 4 illustrates the interactions between various elements at the ENSAM and within a company, highlighting the flow between objectives, activities, resources and actors involved in a manufacturing context which are represented in Section 2 of this paper. The objective focuses on ensuring that parts and assemblies are manufactured to precise specifications. This objective is assessed through various performance criteria, such as “company constraints: 100%” and “Handling machine tools normally: 100%”. These criteria evaluate how well the objective is being met both in the educational and industrial contexts. The objective is linked to two distinct activities: one in the context of training at the ENSAM and the other in the company. At the ENSAM, the activity revolves around the student acquiring theoretical knowledge and skills through courses such as “Materials science” and “Digital manufacturing chain”. In the company, the activity focuses on “Performing manufacturing operations” which includes tasks such as cutting, assembly, surface treatment, and finishing. These operations form the core of the company’s manufacturing process, and the student is expected to apply their academic training in this professional environment.

These activities are set within two distinct situations: one at the ENSAM and the other in the company. The ENSAM situation represents the academic environment where theoretical learning takes place, while the company situation reflects the industrial environment where practical, hands-on manufacturing operations carried out. To achieve the objective, the Actor (the student or the company’s employee) engages in a structured sequence of actions, known as a scheme, which involves mobilizing both personal resources such as time management and external resources available in the company like the in-house CNC program and manufacturing materials. This integration of resources and actions ensures that the manufacturing objectives are met.

The competence map illustrated in Figure 4 serves as the foundation for developing a targeted training framework. This map, which reflects the practical skills and knowledge required in both educational and industrial environments, forms the basis for the formulation of a specific competence “Manufacture parts and assemblies to meet specifications”. The decision to incorporate this competence is directly informed by the specific industry needs identified in the 2022 report, particularly the need for precision in manufacturing processes in the battery sector.

The choice of the ENSAM to host this competence development program is strategic. The ENSAM, with its longstanding expertise in engineering education and its direct collaboration with industrial partners like Verkor, is uniquely positioned to implement a training program that aligns with academic learning with industrial requirements. The institution’s deep integration with industry ensures that the competences taught in the program are directly translatable to the operational needs of companies.

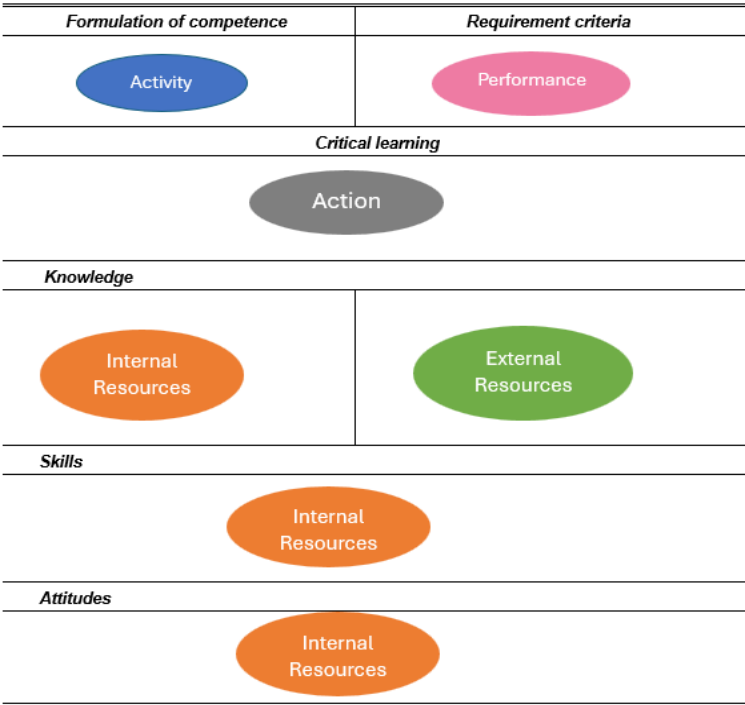


Figure 5. Mapping competence elements to the training program.



Figure 5 outlines the breakdown of this competence into its constituent elements — requirement criteria, critical learning points, and resources (both internal and external). The activities depicted on the map are transformed into the formulation of the competence, where performance is defined by specific requirement criteria, and actions are translated into critical learning points. Additionally, the knowledge, skills and attitudes are considered internal resources essential for a student or employee to acquire this competence. The knowledge section also identifies the external resources needed to successfully achieve these outcomes. This structured approach ensures that the training program is comprehensive and specifically designed to bridge the gap between educational theory and practical application in the workplace.

Building on this analogy, the targeted competence can be defined within the training program. This step involves translating the theoretical elements of the analogy into practical competences, tailored to the specific educational and professional requirements of the program. Table 1 details this competence, illustrating the requirement criteria, critical learning points, and the associated resources (knowledge, skills and attitudes) necessary at different levels of proficiency in the program.

Table 1. Competence “Manufacture parts and assemblies according to specifications”.

<b>Formulation of competence</b>		<b>Requirement criteria</b>	
Manufacture parts and assemblies to meet specifications		<ul style="list-style-type: none"> <li>▪ Using numerical control programs</li> <li>▪ Handling machine tools manually</li> </ul>	
<b>Level 1:</b> for a single-function part (S1)	<b>Level 2:</b> for a simple single-function system (S2)	<b>Level 3:</b> for complex, multifunctional systems (S3)	<b>Level 4:</b> for a complex, multifunctional system, including electronics and documentation in English (S4)
<b>Critical learning</b>			
<ul style="list-style-type: none"> <li>▪ Modify a mechanical system based on new specifications to meet a specific need</li> <li>▪ Safely operate suitable machines to machine parts in different materials from a design drawing</li> <li>▪ Use a technology platform to assemble functional electrotechnical systems</li> </ul>			
<b>Resources for levels 1, 2 and 3</b>		<b>Additional resources for level 4</b>	
<b>Knowledge</b>			
<ul style="list-style-type: none"> <li>▪ Digital manufacturing chain: appropriate protective equipment (EPI, EPC), conventional machining, plastic deformation (forming), welding, additive manufacturing and composites, vector chain and numerical control program.</li> <li>▪ Materials science: friction, stress, deformation, strength of materials, process/structure relationships, inertia.</li> <li>▪ English: basic communication and technical vocabulary.</li> </ul>		<ul style="list-style-type: none"> <li>▪ EEA: electrical safety standards, general DC and sinusoidal electricity, three-phase systems, motors, power electronics, function of electronic components.</li> <li>▪ English: technical vocabulary of manufacturing processes.</li> </ul>	
<b>Skills</b>			
<ul style="list-style-type: none"> <li>▪ Work safely, analyse actions and take corrective measures.</li> <li>▪ Implement basic manufacturing processes.</li> <li>▪ Control and analyse experimental results as part of a quality approach to validate production.</li> <li>▪ Define the part-machine connection, symbolize the positioning and holding parts.</li> <li>▪ Choose manufacturing conditions adapted to the machining objective, taking into account technical and economic criteria.</li> <li>▪ Produce a complete preliminary manufacturing project for the series studied, based on the technical and economic context of the case study.</li> <li>▪ Communicate simple information in English.</li> </ul>		<ul style="list-style-type: none"> <li>▪ Carry out computer-aided manufacturing of a complex mechanical part, based on the definition drawing and 3D model of a part.</li> <li>▪ Assemble an electronic system using solder and appropriate tools (pliers, multimeter, etc.).</li> <li>▪ Assemble electronic systems, electrotechnical components and mechanical parts to create a complex system.</li> <li>▪ Describe a manufacturing process in English.</li> </ul>	
<b>Attitudes</b>			
<ul style="list-style-type: none"> <li>▪ Prevent risks by adopting responsible behavior.</li> <li>▪ Handle machines and tools safely and accurately.</li> <li>▪ Demonstrate organizational skills to improve efficiency.</li> </ul>			

## 4 CONCLUSION

In conclusion, the integration of competence maps as a common language between training institutions and companies offers a strategic solution to the growing recruitment challenges in the industrial sector, particularly in the context of industry 5.0. As demonstrated in this study, competence maps serve as a vital tool in bridging the gap between the evolving needs of companies and the competences provided by educational programs. By clearly defining and visualizing the competences required in specific job roles, these maps enable the development of targeted training programs that align with real industrial needs. This approach not only enhances the employability of graduates but also supports companies in overcoming recruitment difficulties by ensuring a workforce equipped with the necessary competences. The successful application of competence maps, as seen in the battery sector with the collaboration between Verkor and the ENSAM, underscores their potential to drive both educational and industrial advancement, ultimately contributing to organizational resilience and performance. However, the research question regarding the specific effectiveness of these training programs, especially in relation to competence maps, remains unanswered. Future research should explore how well these programs meet industry expectations by collecting detailed data on competence acquisition and employment outcomes. While initial findings indicate that collaborations between universities and industry improve workforce readiness, the claim that this approach enhances employability requires further evidence, such as employment statistics and industry feedback regarding competence fulfillment.

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