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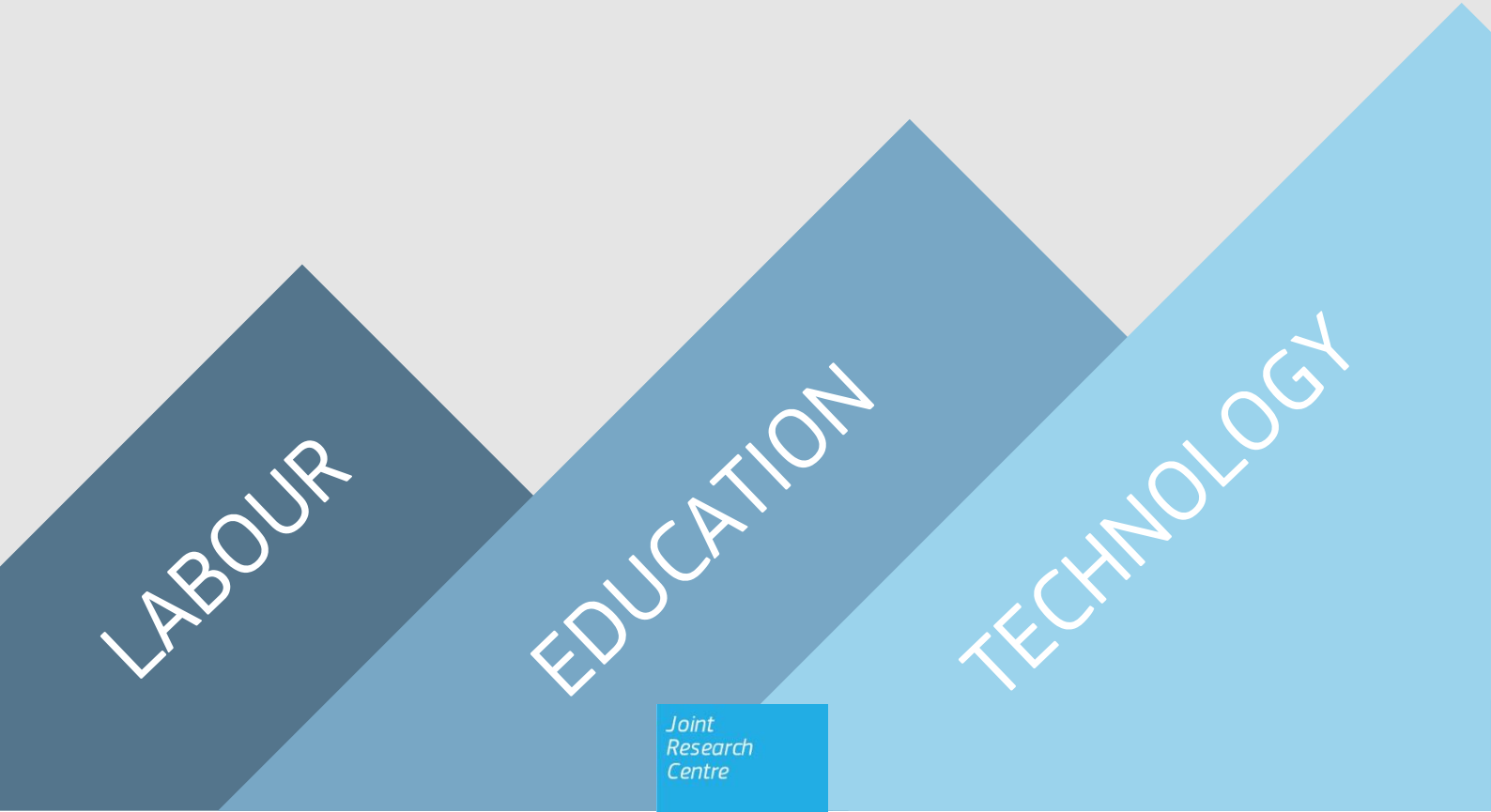

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A unified conceptual framework of tasks, skills and competences

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Abstract

S*kills* and *competences* are frequently invoked by policy–makers in reference to labour market developments and education objectives. However, these concepts have different meanings across academic disciplines such as sociology, economics, and education. This paper proposes a unified conceptual framework for tasks, skills and competences. We start from the concept of *task*, as the smallest unit of work involved in an economic process. S*kills* are defined as the ability to perform tasks. Similar tasks are grouped into *task domains*, which are bundled by employers into *jobs*. Likewise, similar skills make up *skill domains,* while *competence* is the ability to master skills across domains. This framework has two major advantages. First, it provides distinct definitions of relevant concepts and the relations between them. Second, it bridges the socio-economic concepts of skills and tasks, which relate to the labour market, with the education and training literature, which focuses on skill and competence development as learning objectives. We also propose a way to measure the different concepts empirically.

Keywords: Tasks, skills, competences, framework

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Contents

1. Introduction and policy context

Skills are at the heart of European policy. The New Skills Agenda for Europe[1] states that skills are a pathway to employability and prosperity, and a catalyst in the virtuous circle of job creation and growth. It proposes ten actions to make the right training, skills and support available to citizens so that Europe can face the challenges of global competition, skill-biased technological change and population ageing. The European Pillar of Social Rights[2] gives an even broader role to skills by stating that they are important not only to manage successful transitions in the labour market, but also to participate fully in society. In terms of specific actions and initiatives, the Upskilling Pathways and the Key Competences for Lifelong Learning are building blocks of the Pillar and of the New Skills Agenda for Europe. They aim to help people, including adults with low skill levels, acquire the core set of skills necessary to work and live in the 21st century. The underlying assumption is that everyone has the right to quality and inclusive education, training and lifelong learning in order to maintain and acquire skills. Thus, the fundamental question for EU policy-oriented research in the area of skills is "how well do systems responsible for skills development (i.e. education and training) function in providing required skills and addressing skills mismatches, thus ensuring good labour market and social outcomes?" (ESTAT/EMPL, 2016).

Answering this question requires a well-defined framework and system of indicators for measuring skills at large. Although there is a proliferation of indicators and benchmarks for skills in the EU, such as the *World Indicators of Skills for Employment (WISE) database*[3] or *Skills for Jobs Indicators*[4] by the OECD, or the *European Skills Index* by Cedefop[5], there is no common and consistent conceptual definition, which makes them difficult to compare, sometimes even contradictory. A consistent definition and conceptual framework for skills at large is still needed (Green 2011).

Part of the problem is that the area of skills straddles across disciplines, which can be themselves inconsistent in their approach and basic concepts, and it is not always clear which is the perspective taken. For instance, although the policy discourse mostly refers to the economic concept of *skills* (with a focus on the labour market), when it comes to the development of learning outcomes and the process of skills development the educational concept of *competences* is often used. It is unclear how these two central (and at least partly overlapping) concepts relate to each other. In some recent policy documents and discussions, skills and competences are used interchangeably, in some others they seem to refer to different things.

This paper proposes a unified conceptual framework for tasks, skills and competences. We present simple definitions of the main concepts in this area that are consistent with the relevant disciplines and approaches; in particular, we focus on bridging the socio-economic approach centred in the application of skills to tasks in the labour market and the educational perspective focused on the development of skills and competences in education and training. Although our primary perspective is the world of work and employment – and what these concepts mean in the labour market – this framework also tries to interface with the understanding of skills and competences used in the field of education. We hope that this paper can foster inter-discipline dialogue and feed into subsequent efforts of measuring and monitoring skills at large and at the European level.

[1] http://ec.europa.eu/social/main.jsp?catId=1223

[2] https://ec.europa.eu/commission/priorities/deeper-and-fairer-economic-and-monetary-union/european-pillar-social-rights_en

[3] https://www.oecd.org/employment/skills-for-employment-indicators.htm

[4] https://www.oecd.org/employment/getting-skills-right-skills-for-jobs-indicators-9789264277878-en.htm

[5] https://skillspanorama.cedefop.europa.eu/en/indicators/european-skills-index

2. How the concepts are used in different disciplines

There are differences, both within and across disciplines, in how the concepts of skills and competences are defined and linked to each other, and in the purposes for which they are used (see Green 2011 and Payne 2017).

The economic concept of skill is broadly related to that of *human capital,* which encompasses all individual attributes that have a market value (Green, 2013). In economics, skills are used to explain or account for a variety of phenomena such as wage inequality, economic growth or organizational performance (e.g., Hanushek and Woessmann 2012; Hanushek et al., 2015). Recent applied economic research has shown that, besides 'cognitive skills', the so-called 'non-cognitive skills' and personality traits also play an important economic role (e.g., Heineck and Anger, 2010, Heckman, 2012). In general, the term *competence* is not often used in this literature.

In economics, the term *skill* is also used as a defining element of occupations, which are in turn typically related to the concepts of division of labour. For example, the International Standard Classification of Occupations by the International Labour Organisation defines skill as "the ability to carry out the tasks and duties of a given job", and distinguishes between *skill level* and *skill specialization* to classify different occupations (ILO 2012). From a sociological perspective, skills in relation to occupations are one of the determinants of the position that individuals occupy in the social structure, or social class (Vallas 1990; Warhurst et al. 2017).

In contrast, in psychology and education the focus is generally on how learning outcomes are achieved and can be enhanced. What is seen as an input in economics and sociology is seen as an output in psychology and education. Hence the need in these areas to disentangle the components of learning outcomes and to come up with the more comprehensive concept of competence, which encompasses knowledge, skills and attitudes as elements that can be acquired and developed in education and training episodes. Even within these disciplines, there is no broadly accepted definition of competence, let alone a unifying theory (Weinert 2001; Delamare Le Deist and Winterton 2005; Winterton et al. 2006).

To some extent, *skills* in economics is conceptually similar to *competence* in psychology and education (Green, 2011), and as previously mentioned the two terms are often used interchangeably. However, they are not identical concepts and using them as synonyms can lead to confusion. In educational research, skills are a component of *competences*. Although *knowledge* and *attitudes* are also attributes of individuals with clear economic value, they are fundamentally different from skills in the way they are acquired and applied to tasks in labour markets.[6] A clear demarcation of each of those concepts is necessary to inform education and training systems, but also to correctly interpret changes in labour markets in terms of their implicit skills demands.

3. Main definitions and conceptual framework

This section provides definitions for the concepts of **task, skill,** and **competence** which are used throughout the paper and introduces the links between them. These concepts

[6] A concept that is strongly linked to skills and which has become increasingly popular within labour economics lately is that of tasks (Autor 2013). A task can be simply defined as a unit of work activity that produces output; from this perspective, a skill can be defined as the ability to perform a particular type of task, consistently with the ILO definition. This approach opens up the possibility of a conceptualisation and classification of skills that is anchored in what people actually do at work, and thus can be used to bridge the supply side concept of skills (linked to competence development) and the demand side of tasks (linked to the performance of work).

refer to attributes of *individuals* (skill and competence) or to the *activities* that they carry out (tasks and occupations).

In this sense, the two groups of concepts refer to the supply and demand sides of the labour market. On the supply side, we have concepts such as skill or competence, which apply to individuals and refer to potentialities, that is, to *abilities to do something*. On the demand side, we have concepts such as tasks, tasks bundles, and jobs, which apply to activities carried out by individuals and refer to s*pecific acts of transformation* within the context of economic organisations (i.e., labour inputs into production processes).

Although both sides are distinct, they are necessarily linked and to a large extent correspond to each other in ways that we will discuss later: for instance, a *skill* (supply side) is an ability to perform a specific *task* (demand side); a *cluster of tasks* (demand side) can be associated to a *competence* (supply side).

3.1 The underlying relation between tasks and skills

Tasks

From a material perspective, the economy is a process of transforming inputs into outputs which have economic value. Work is an input in this process, and tasks are more or less discrete units of work that contribute to produce the final output (Autor, 2013)[7].

In analytical terms, the level of granularity or discreteness of the concept of *task* is arbitrary. In practice, it depends mainly on the complexity of the economic process and on the forms of work organisation that hold in each moment of history and even in each industry, sector or firm. For instance, Taylorism as a form of work organisation explicitly aimed at discretising, standardising and simplifying as much as possible the tasks of each worker, in order to increase the degree of managerial control of the labour process, reduce wages and increase efficiency (Braverman 1974).

In other words, the idea of tasks as the smallest unit of labour input presupposes a degree of structure and differentiation that is the deliberate result of a historical process of work organisation and division of labour. In itself, work as transformative activity need not be split into tasks, but can be continuous and undifferentiated. The breakdown of work into tasks, especially as it accelerated during the Industrial Revolution, is associated with gains from specialisation and exchange. This phenomenon is secularly increasing in the economic process as a whole, because of the unfolding of the division of labour and growing economic complexity.

Although the differentiation of labour into tasks is historically determined by the division of labour and economic complexity, the level at which tasks are defined analytically is arbitrary and ultimately depends on the research objectives. A task can be defined at the most discrete level possible: a very small unit of labour input within a very specific transformation process, such as fastening a screw or writing an e-mail. It can also be defined as a complex cluster of different sub-tasks, such as factory assembly, or managing correspondence. In fact, we could go as far as considering the economic process

[7] The main proponent of the tasks approach, David Autor, uses the concept at a level of generality that does not specify whether the task has to be performed by humans or not (it could be performed by a robot, or by an animal). This is intentional, because it allows to explicitly discuss under which conditions will the task will be performed by a human: assuming technological feasibility, whether a task is performed by a human or by a machine depends on the relative cost of each alternative. For us, this is problematic because machines lack real agency, and thus they can always be understood as tools used by some human worker, who would be the one providing the labour input in the last instance. In this paper, tasks are assumed to refer always to human input following the approach of Fernández-Macías and Bisello 2020.

as a unique all-encompassing and very complex task. However, for definition and classification purposes it is useful to regard them at their most discrete level possible.

Therefore, we define **task** as a discrete unit of work activity that contributes to the production of economic output. To classify tasks, we use the taxonomy proposed by Fernández-Macías and Bisello (2020) that is organised along the dimensions of content and method (see Figure 1 below).

The first dimension refers to the **content** of the tasks themselves, which is what people do at work. It is based on the object that is transformed in the production process (things, ideas or social relations) and on the type of processing involved (which is strongly linked to the types of skills required).

At the highest level of generality, this taxonomy differentiates three domains or categories of task contents: i) physical tasks (that operate on things), further subdivided into strength, dexterity and navigation; ii) intellectual tasks (that operate on ideas), subdivided into information processing and problem solving; and iii) social tasks (that operate on people), subdivided into serving, teaching, selling, managing and caring. Within each of these high-level categories, different subcategories of tasks are differentiated based on their typical skills requirements, with further low-level indicators under each of the subcategories. Although there is an obvious arbitrary aspect in the selection of categories and the boundaries between them, this proposal reflects the main elements identified in the specialised literature on this subject (see Fernández-Macías and Bisello 2020).

The second dimension of this taxonomy refers to the **methods and tools** used to perform those tasks (how people work) and reflect the forms of work organisation and technology used in production. See Figure 1 below for more details on this task classification.

Implicit in the classification shown above is the fact that, even though they are defined as discrete and distinct units of work, tasks can be related to each other by similarity. The reason behind this similarity is that different tasks can share some key properties, most importantly with respect to the object on which they operate (things, ideas or people) and the type of transformation process they entail (for instance, all codified information processing literacy tasks involve cognitive processes such as comprehension and expression operating on different types of text). These relations of similarity between tasks allow us to classify them as in Figure 1, and is also reflected in relationships between skills and competences that we will discuss later.

Figure 1 - A classification of tasks according to their contents and methods

A. **In terms of the content of work**	B. **In terms of the methods and tools of work**
1. Physical tasks a. Strength b. Dexterity c. Navigation 2. Intellectual tasks a. Information processing i. Processing of uncodified information ii. Processing of codified information 1. Literacy a. Business b. Technical c. Humanities 2. Numeracy a. Accounting b. Analytic b. Problem solving i. Information gathering 1. Information search and retrieval 2. Conceptualization, learning and abstraction ii. Creativity 1. Creativity 2. Planning 3. Social tasks a. Serving/attending b. Teaching/training c. Selling/influencing d. Managing/coordinating	1. Methods (work organisation) a. Autonomy i. Latitude ii. Control b. Teamwork c. Routine i. Repetitiveness ii. Standardisation iii. Uncertainty 2. Tools (technology) a. Machinery (non-digital) b. Digitally-enabled machines i. Autonomous (robots) ii. Non-autonomous 1. Computing devices/ICT a. Basic ICT b. Advanced ICT c. Specialised ICT 2. Others

Source: Fernández-Macías and Bisello (2020)

Skills

Skill can be generally defined as the ability to perform a task well. Although a skill is an attribute of individuals, it necessarily refers to a specific activity (or as we are saying, act of transformation). In our context, the specific act of transformation that the concept of skill refers to is a discrete task within a particular work process. Therefore, each task has an associated skill and its completion is skill-dependent.[8]

For our current purposes, skills have two crucial features:

1. A skill can be graded depending on how well the task is performed. In other words, skill is a relative concept, as one can be very skilled or not very skilled in doing something. This gradation is specific to each type of task.
2. A skill is something that is acquired and that can be improved by different means, mostly by learning and practising.

Because skills are directly related to tasks, we can classify them in a way analogous to the one presented earlier in Figure 1, along three categories:

1. *Physical skills*: ability to do well physical tasks, involving strength or dexterity.
2. *Intellectual (or cognitive) skills*: ability to do well intellectual tasks, involving information processing or problem-solving.
3. *Social skills*: ability to do well social tasks, involving attending, teaching, influencing or managing.

Depending on the degree of granularity or discreteness aimed for, we could construct skills classifications and indicators at different levels of the tasks framework presented in Figure 1.

The *methods* and *tools* dimension of the tasks framework refers to *how* rather than *what* is done at work, and therefore there is not such a clear skills equivalency. However, there can be skills associated with those categories too, to the extent that operating with a particular tool, or under a particular form of work organisation, involves also physical, intellectual or social tasks. For instance, operating with computers requires some physical dexterity skills (for typing), intellectual information-processing skills, and problem-solving skills. Working in teams requires some social skills.

Skills hierarchy

Skills can also differ in complexity. A more complex skill is one that incorporates or requires mastering lower-level skills. In other words, less complex skills are enablers of or pre-requisites to the acquisition of more complex skills.

This complexity property of skills implies a vertical or hierarchical relation between skills, in two possible ways:

- *Development*, whereby one skill may develop into a more complex one (Panel A of Figure 2).
- *Aggregation*, whereby two or more skills are combined into a more complex one (Panel B of Figure 2).

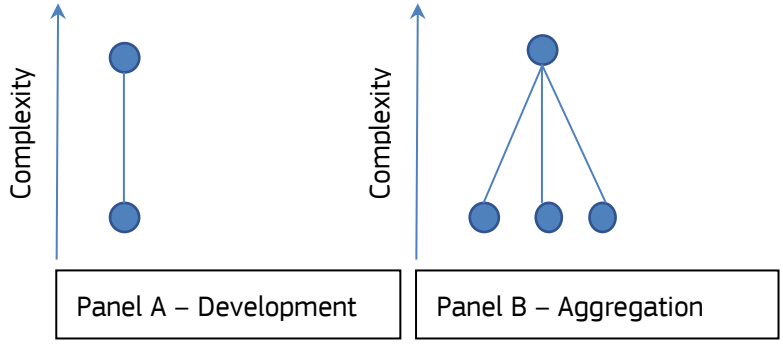
An example of a complex skill developed from a simpler one could be a very specific numeracy skill, for instance making powers of a number: this skill requires having acquired first the skills of multiplying, which in turn requires having mastered adding. An example of a complex skill aggregated from many lower-level skills could be programming, which

[8] This definition of skill is very broad and abstract and, therefore, it could refer to a person or a machine. For instance, an Artificial Intelligence (AI) agent could be *skilled* in the performance of a specific task. However, as previously mentioned the fact that machines lack agency makes this concept problematic, and in any case all the discussion in this paper refers to human beings.

requires both literacy and numeracy skills, on top of technical skills related to the use of digital tools.[9]

Based on this relation of **hierarchy** between skills, they can be classified and compared according to their complexity. Simple skills are those that do not require mastering additional lower-level skills; the more low-level skills are required for mastering a given skill, the highest its complexity. Also, we can call basic or foundational skills those that are necessary for acquiring many important higher-level skills.

Figure 2 - Examples of vertical/hierarchical relations between skills



Skills transferability

Although the concept of skill is specific to a particular task, skills can be laterally transferable to other tasks insofar as those tasks share some properties. The transferability of skills across tasks requires necessarily some common properties in the related tasks, but these common properties may not be obvious at all.

The degree of transferability between skills varies, depending on the similarity between the tasks considered. Some skills may have limited transferability because they relate to tasks whose properties make them peculiar (so that there are few similar tasks). Some other skills may relate to tasks whose properties apply to many other tasks, and thus those skills will have a high transferability. The range of different skills to which a skill may be transferable indicates how general or specific a skill is.

Based on this transferability attribute, and consistently with the literature, we adopt one additional dimension to classify skills:

- *Generic skills* are transferable to many similar tasks (to varying degrees).
- *Specific skills* apply only to a specific task and therefore are not transferable.

Ultimately, skills **generality** can be understood as a continuum, ranging from very task-specific skills to very generic skills.

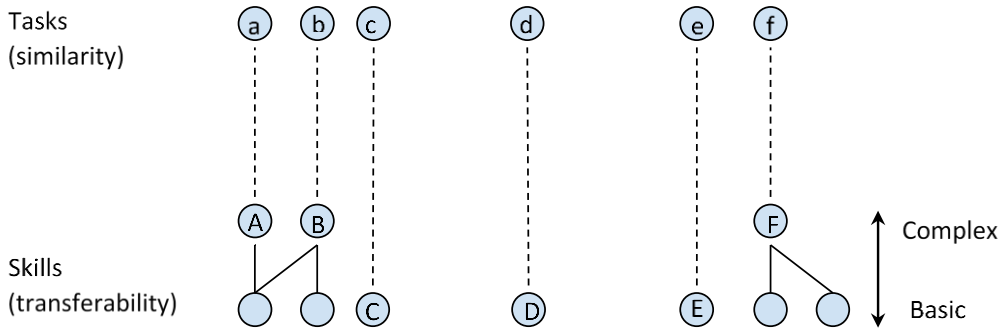
Tasks and skills domains

We previously defined task as a discrete unit of work activity that contributes to the production of economic value, and skill as the ability to perform a task well. Figure 3 represents how tasks and skills are linked, in a very simplified way. As explained above, to each task corresponds one skill and the (horizontal) distance between tasks (skills)

[9] Unlike skills, it does not make sense to characterise tasks as more or less complex because they are simply units of work in a production process that do not have a hierarchical position as such. If anything, the skill required to perform a task may be more or less complex. For instance, suppose the task of making the power of numbers. The skill to do that requires having mastered the skill of multiplication and before that the skill of addition. However, the task itself does not require actually adding and multiplying numbers.

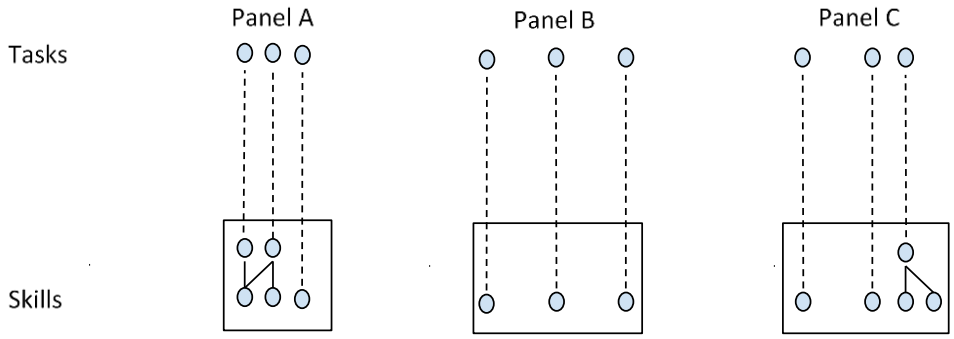
indicates the similarity (transferability) between them.[10] The complexity axis is only present in the skills space and for simplicity we only consider two levels: basic and complex skills. In this example, skills C, D and E are basic ones while skills A, B, and F are complex ones.

Figure 3 - An example of tasks and skills spaces



The tasks represented in Figure 3 can be clustered by similarity, represented by their horizontal proximity. For instance, tasks **a**, **b** and **c** above can be put together in a cluster, task **d** in another, and tasks **e** and **f** in a third one. We refer to any cluster of tasks as a **task domain**. By analogy, a **skill domain** can be defined as the corresponding cluster of skills (and their associated lower-level skills). Again, in Figure 3 we could identify three clusters of skills or *skills domains* (*A*, *B* and *C*; *D*; and E and F). In Figure 4 below, we present other examples of task and skill domains.

Figure 4 - Examples of tasks and skills domains



Even though all **task domains** depicted are formed by three tasks, the corresponding **skill domains** are very different. The domain in Panel B is composed of tasks that only require basic skills, while the domain in panel A is formed by tasks that require three basic and two complex skills, and the domain in panel C requires four basic and one complex skill. Apart from the number of skills and their complexity, a crucial difference between the domains is how similar are the tasks involved. While in the domain represented in Panel A the tasks are very similar, in Panels B and C they are quite dissimilar, as represented by the horizontal distance between them.

[10] In the diagram, there are more skills than tasks simply because some of the tasks depicted here require complex skills, which themselves build on basic skills. The tasks corresponding to these basic skills are not represented.

We can define the main attributes of **skill domains** as follows:

- The *complexity* of a skills domain is related to the complexity of the skills that compose it. The domain in Panel B is less complex than those in panels C and A.
- The *consistency* of a skills domain depends on the similarity of the tasks that constitute it, and hence on the transferability between the corresponding skills. The domain in Panel A is highly consistent because the tasks are similar among them and the related skills are to a great extent transferable. In contrast, the domains in Panels B and C are less consistent because the necessary skills to perform well in the domain are also quite distinct (and less transferable).

The attributes of complexity and consistency only apply to *skills domains*, but since every skill has an associated task, they can be also indirectly applied to task domains. In other words, a task domain whose associated skills domain is complex but consistent can also be considered as a complex and consistent task domain.

Since we have defined (task or skill) domain just as a cluster of tasks or skills, any domain is conceivable in principle. But only domains that have some degree of consistency have practical value, and they are implicitly used by organisations to structure labour input into production (resulting in jobs or occupations, which are consistent clusters of tasks, more on this later) and by educational systems to organise the learning process (resulting in competences and curricula, which are consistent clusters of skills). An example of skills domain with practical value is "digital skills", which can be defined as a cluster of transferable and hierarchically related skills linked to the performance of tasks involving digital tools.

3.2 Competences

We can now define **competence** as *a general ability to do well in a particular task domain*. By definition, there can be as many competences as task domains can be defined.

It is important to note that the concept of competence is related but not synonymous to the concept of skills domain, because it includes much more than just a cluster of skills. This is because "to do well in a particular task domain" requires not only to have a number of specific skills, but also to have a general understanding of the domain (knowledge) as well as certain attitudes that help to do well in that domain. Thus, there are the three elements of competence:

1. *A set of key skills for the domain*. Notice that a task domain can contain a potentially infinite number of tasks, and it is thus impossible for any person to be skilled in every possible task within a domain, strictly speaking.[11] The individual must possess some key skills in the domain; the transferability property of skills should enable her to deal with other (similar) tasks in that domain.
2. *A general knowledge of the domain,* that enables an understanding of the object and transformation processes of the tasks involved, which will allow to respond better to new tasks or situations of uncertainty that may emerge in the domain.
3. *A particular set of attitudes* which are beneficial for performance in the domain and to act when confronted with uncertainty in the domain.

These components are what enable someone to successfully confront different and uncertain challenges and tasks in a particular domain. For instance, being digitally competent does not mean having all the possible skills in the digital domain, but having a certain level of key skills in the digital domain, some general knowledge of that domain

[11] That is why in the definition, we say that competence is "a general ability to do well in a particular task domain", rather than "being skilled in all tasks of a particular domain".

and a particular set of attitudes (such as attention to detail, openness to change, or capacity to focus) that are useful to confront different tasks and situations in the digital domain.

The properties that we previously used to characterise skills (and indirectly tasks) domains (consistency and complexity) are directly related to the difficulty of attaining competence in a **domain**. In general, the more complex and the less consistent a domain is, the more difficult it will be to attain competence in such a domain, because the requirements in terms of skills, knowledge and attitudes necessary for the associated competence will be more demanding.

Knowledge

For our purposes, **knowledge** is the cognitive outcome of an assimilation of facts and figures, concepts, ideas and theories which are already established (*know-what*) about a domain. Knowledge can be acquired and developed in the context of the formal education system, in so-called *non-formal* learning settings – structured learning outside the education system, such as workplace training – and in *informal* settings through one's life experience.

Because we restrict the definition of skill to a specific task or work activity, a skill does not necessarily require knowledge. It is possible to have "the ability to do a task" without knowing facts, figures, ideas and theories. An "operational'" knowledge that allows carrying out the task well can be enough. However, since competence refers to the ability of doing well many different tasks in a domain (potentially including situations that the person may never have confronted before), some knowledge of the domain is necessary. Knowledge supports the transferability of skills to similar tasks, the capacity to respond to uncertainty and to find solutions to new problems in a domain.

Attitudes

In our context, **attitudes** can be defined as any personality trait that can be learned (i.e., not innate) and that contributes to a more effective performance in a domain.[12] Attitudes are of a psychological, emotional and behavioural nature, rather than of a cognitive or operational nature (contrary to skills or knowledge). While they can evolve over the life course, attitudes are mostly acquired in childhood and remain relatively stable attributes for adult individuals (Caspi et al. 2005).

In some cases, it may be difficult to differentiate attitudes from skills, since both can be learned and can be beneficial for the performance of a task or set of tasks. For instance, social tasks often require empathy; since empathy can be trained, it can be considered a skill; but it is also a psychological trait rather than an operational ability, and thus it can be considered an attitude. Here we refer to attitudes as pre-dispositions to act in a particular way and that are relevant for the performance in a task domain rather than a specific ability to perform a task as such. In practice, the same trait can be considered an attitude or a skill depending on the specific task or domain in question. For instance, for the task of providing psychological care, empathy can be considered a skill; whereas for statistical analysis empathy can be a desirable attribute for a better competence, but it cannot be considered a skill since statistical work does not require empathy as such.

Attitudes are more general than skills and knowledge. Whereas skills are by definition linked directly to specific tasks, and knowledge refers to objects and processes linked to a

[12] One could argue that attitudes can also affect skill, i.e. the ability to perform a specific task. However, since we have made a narrow and technical definition of tasks, the effect of attitudes would be marginal at that level, while they would be very relevant at the level of competence, which involves dealing with more uncertainty and complexity.

particular domain, attitudes are not task- or domain-specific. What is specific to each domain is the relative importance or relevance of specific attitudes for doing well in such a domain. For instance, concern for others can be an important attitude for teachers, but irrelevant for software developers; whereas openness to change can be a positive attitude in many different domains.

The concept of attitudes as a component of competence is similar to other concepts used in occupational or psychological research. For instance, the O*NET occupational database describes 16 "work styles" as personal characteristics that can affect how well someone performs a job: achievement/effort; adaptability/flexibility; analytical thinking; attention to detail; concern for others; cooperation; dependability; independence; initiative; innovation; integrity; leadership; persistence; self-control; social orientation and stress tolerance.

A production function approach to the concept of competence

Building on the previous ideas, we can use a production function approach to discuss and study the concept of competence. In general, the competence of individual *i* in the domain *j* would be given by:

$$C_{ij} = g(E_{ij}).f\left(S_{ij}, K_{ij}, A_{ij}\right)$$

Where S_{ij}, K_{ij}, A_{ij} stand for skills, knowledge and attitudes, respectively. The other component of competence, E_{ij}, is an efficiency term, inspired by total factor productivity in the standard production function in economics. This efficiency term implies that, for equal amounts of the remaining components, there could be different competence levels depending on how efficiently the components are combined.

We propose that this efficiency term can be linked to the concept of **expertise**, which can increase competence for a given level of skills, knowledge and attitudes by improving the efficiency of their use. Expertise involves a deeper understanding of the domain's processes and context that can be acquired mainly by accumulating experience in the domain, rather than in learning contexts. We will come back to this concept of expertise later, when we present a life-course approach to skills and competences.

The functional form *f* should have the following properties:

- Allow for the components' substitution;
- Be multiplicative, so that a balanced combination of components yields a better outcome;
- Allow each component to have different weights.

A Cobb-Douglas production function encompasses all these features and could be used to illustrate a particular example of the desired production function:

$$C_{ij} = g(E_{ij})S_{ij}^{\alpha}K_{ij}^{\beta}A_{ij}^{\gamma}$$

This production function is general enough to encompass different weights $(\alpha, \beta, and\ \gamma)$ for each of the components, so that in some domain skills can be more important than attitudes, while in other domains knowledge can be more important than skills, etc. Depending on the rate of substitution between the components, we can have similar levels of competence with different combinations of its components.

Thus, competence can be modelled as a continuous variable that results from the combination of its components and can change due to shifts either in the efficiency term or in some component. In Section 4, we introduce a dynamic perspective to these supply side concepts, by taking a life course perspective.

3.3 Jobs as a special type of task domain

The conceptual framework proposed here defines task as a discrete unit of work activity and a task domain as any cluster of tasks. The equivalent concepts in the supply side of the labour market would be skill and competence.

At the level of generality of the previous discussion, any task domain is conceivable, including one that encompasses the entire space of tasks. Indeed, there are some possible task domains that would make no sense because they bundle tasks that, in practice, would be impossible to be performed well by any individual (no individual would be able to master all the necessary skills, nor acquire all the necessary knowledge and attitudes). In contrast, other possible task domains have a consistency that makes them practical for arranging work patterns in economic organisations. Indeed, economic organisations typically try to bundle the tasks to be performed by workers in a way that is efficient and maximises profit. For an illustration of how tasks are bundled into jobs, see box 1 below.

Box 1: How do organisations bundle tasks into jobs?

Let us suppose that we want to set up a productive organisation to provide some goods to the market, shoes for instance. We initially assume a given amount and type of demand, and a given technology. With those conditions, we will have to combine a number of inputs, including labour. This labour input can be split into a vector of specific tasks that have to be carried out, each with an associated amount of labour input necessary (x amount of working hours for cutting the leather, x amount of hours for sewing, etc; there will also be many administrative, design, marketing and other types of tasks). Let us say there are in total about 1,000 distinct tasks to be carried out, each with their associated necessary labour input.

As implied by Ronald Coase in his classic treatise on the nature of the firm (Coase 1937), it would be impossible to contract via the market the labour input to perform each of the tasks individually for a given production process because the coordination costs would be enormous. Therefore, tasks are bundled into jobs to be performed by workers under a labour contract. But how do we bundle tasks in the most efficient way?

As previously discussed, the fact that each task requires a different skill, and that skills are related by transferability and hierarchy, suggests that it makes sense to bundle tasks that require related skills. This way, jobs will tend to involve task domains which are consistent, and occupational careers will tend to imply increasing levels of complexity (because mastering low-level skills gives access to related higher-level skills).

But for a specific productive organisation, the amount of demand may not allow a very detailed task specialisation (Adam Smith famously argued that the division of labour is limited by the size of the market), and perhaps there will be several jobs requiring skills across different domains (in other words, jobs with inconsistent task domains). Task bundling may also be affected by business strategy: we may prefer to limit task specialisation and hire competent but generalist workers with a high degree of skills and autonomy (for instance, to produce luxury customised shoes), or opt for a Taylorist-type extreme task division limiting generalist skills and autonomy (to produce cheap standardised shoes). There are many other factors that can affect the bundling of tasks into jobs in particular organisations, from industrial relations systems and cultural norms to personal relations. Therefore, jobs will partly, but never perfectly, reflect skill domains.

We can thus define a **job** as consistent bundle of tasks (or task domain) that is associated with a specific position within an economic organisation, for some level of task consistency. Since we previously defined *competence* as a general ability to do well in a particular task domain, *competence* would be the supply-side equivalent to the demand-

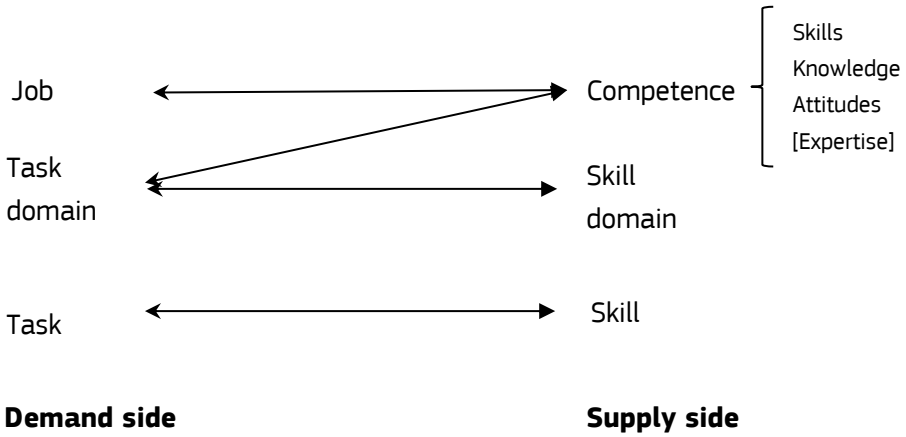
side concept of *job*. That is why we speak about a "competent cook" or a "competent mechanic".

Finally, **occupations** are groups of jobs that are similar in terms of the competences they require and their hierarchical position within organisations. The concept of occupation, which is regularly used to classify jobs in the economy, tends to reflect more directly the complexity of the domains as previously defined, because they are in fact constructed as groups of jobs that require similar competence levels.

3.4 A unified conceptual framework of tasks, skills and competences

Figure 5 puts together the previously discussed concepts of tasks, skills and competences and illustrates the links between them. This framework classifies the concepts in two sides, depending on whether they refer to the supply or the demand side of the labour market. In the demand side, the key concepts are *task*, *task domain* and *job*, in order of complexity. Tasks are small and discrete units of labour input, task domains are clusters of tasks, and jobs are clusters of tasks used by organisations to structure labour input into their production processes. In the supply side, the concepts are skills, skill domains and competences, again in order of increasing complexity. Skills are abilities to perform specific tasks, skill domains are clusters of skills linked to task domains, and competences are a combination of skills, knowledge and attitudes that allow the worker to do well in a given task domain, or in a job. In this framework, each of the supply-side concepts has one related demand side concept (or two). The relationship between task and skill is strictly one-to-one, as well as the relationship between task domain and skill domain. The demand-side correspondence of the concept of competence is less direct and unequivocal, because it refers to a task domain but there is a certain degree of uncertainty in the definition of such a domain, as previously explained. The concept of competence can apply both to a job (as a particular cluster of tasks, within a productive organisation) and to a task domain.

Figure 5 - Conceptual framework for tasks, skills and competences



4. Competence development: a life course perspective

As described above, the concepts of competence, skills, knowledge, attitudes and expertise refer to potentialities of individuals. These potentialities evolve over the life course as a

result of learning experiences of a formal, non-formal or informal nature.[13] In this section, we follow a life course approach to explore the dynamic aspect of competence and its components.

4.1 The acquisition of competences throughout the life course

It is well established that individuals have the capacity to learn throughout life. Research in neuroscience shows that learning capacity is particularly high in childhood, when the brain has a very high level of plasticity. Starting in adolescence, the brain structure is consolidated by reinforcing (weakening) the most (least) used synapses. During adulthood this plasticity is reduced, which makes learning still possible albeit more demanding from a cognitive point of view. At this stage, the learning capacity is determined by the relation between what we attempt to learn and what we already know. If these are too different, the brain structures must be reshaped, which is particularly demanding. Despite this lower plasticity during adulthood (affecting the capacity to learn new things), cognitive ability and performance are not compromised. In fact, adults tend to show high levels of functionality due to the relative specialisation on specific areas, which makes brain processes more efficient. In sum, through specialisation and experience adults get better at doing what they have already learned.

Educational psychology also assumes that individuals maintain a capacity to learn throughout their lives, but at different degrees and in different ways. For instance, during childhood most of the learning is done through "cumulative learning", whereby new mental schemes or patterns are established. During adolescence and adulthood, most of the learning happens by assimilation and/or accommodation, whereby the result of a new stimulus is generally linked to an existing mental structure, although it can contribute to change it slightly (Piaget 1954).

The learning process, or the acquisition and development of competences (skills, knowledge and attitudes), is also affected by genetic and environmental factors. The latter refers to the types of learning environment one is exposed to and includes how frequently what has been learned is practiced in reality. When learning outcomes are not applied (in paid work or any type of activity), they will not evolve or consolidate as they would if they are applied regularly. If they are only rarely used, they may even depreciate in the long run.

4.2 A dynamic competence production function

Clearly, the competence in a domain, and its constituents, will vary significantly over the life course. Hence, we can add a time dimension to the production function of competence, so that the competence in period t depends on the skills, knowledge, attitudes and expertise at that point in time*:*

$$C_{ijt} = g(E_{ijt}).f\left(S_{ijt}, K_{ijt}, A_{ijt}\right)$$

The level of each of these elements (E, S, K, A) in period t results from the level in the previous period *t-1* and from the experience acquired between *t-1* and t (L_t):

$$X_{ijt} = f\left(X_{ijt-1}, L_{ijt}\right), \text{ where } X = \{E, S, K, A\}$$

[13] We can define these concepts following Cedefop (2014). **Formal learning** refers to learning occurring in an organised and structured environment (such as in an education or training institution or on the job) and that is explicitly designated as learning (in terms of objectives, time or resources). Formal learning is intentional from the learner's point of view and it typically leads to certification. **Non-formal learning** refers to learning which is embedded in planned activities not explicitly designated as learning, but which contain an important learning element. It is intentional from the learner's point of view and it typically does not lead to certification. **Informal learning** refers to learning resulting from daily activities related to work, family or leisure. It is not organised or structured in terms of objectives, time or learning support. Informal learning is in most cases unintentional from the learner's perspective.

The experience, L (which should not be confused with expertise, E), can be of a positive nature - practicing a competence - or of a negative nature - not practicing a competence.

In summary, competence development occurs when either expertise, skills, knowledge and attitudes change over time. The case of expertise is particularly interesting because it allows competence to improve even with constant skills, knowledge and attitudes. One increases expertise by developing an in-depth understanding of the domain that allows using resources (skills, knowledge and attitudes) in a more efficient way. An expert can build on accumulated experience to identify the most efficient strategies for dealing with uncertainty in a given task domain.

4.3 Representing the development of competence over the life course

The development of competence and its constituents is largely specific to each individual, as it depends on individual genetic and environmental factors. However, despite this diversity, it is possible to articulate a set of general principles that would broadly apply to all individuals. Linking insights from educational psychology and neuroscience to the concepts presented in previous pages, we propose the following typical patterns of competence development throughout three main stages of the life course.

1. Childhood and adolescence - Period of initial education and training

As already discussed, learning starts very early in childhood and it initially comprises mostly basic and general knowledge, skills and attitudes. These basic elements will then be developed into more specific and complex ones as people progress in education and in life.

2. Adulthood - Work

After initial education and training, most individuals join the labour market. The knowledge, skills and attitudes accumulated during initial education and training will be put into practice, normally in a specific task domain (or job). In this context, the concept of occupational mismatch (over- and under-education) refers to situations in which the competences (knowledge, skills and attitudes) initially accumulated by the individual are not adequate for the job she takes up when joining the labour market. This mismatch can reflect inconsistencies between the educational system and the available jobs, some dysfunction in the sorting and matching process of individuals to jobs, or individual deficiencies in the processes of competence acquisition or job design (at either side of the market).

Whatever the initial level of competence in the domain and the degree of matching to the actual job performed, continuing work activity in a given domain results in further accumulation of skills, knowledge and attitudes relevant for doing well in that domain. In other words, the level of competence in the domain continues to grow. In fact, experience in the domain contributes to an increasing practical understanding and efficiency in that domain, which allows individuals to develop better strategies to operate and cope with uncertainties in that domain. This accumulation of efficiency and practical understanding of the domain is what we have called expertise, and it can only be acquired through experience and thus at work.

As individuals age, their cognitive abilities start declining. While this process starts already in early adulthood (as early as the twenties), in many cases it is only apparent in late adulthood because the accumulation of expertise more than compensates the declining cognitive ability with a more efficient use of the available skills and knowledge.

3. Old age - Retirement

When individuals retire, they are less likely to put their work-related skills into practice, which contributes to their depreciation. Eventually, in the later stages of life, the cognitive

abilities decline to an extent that not even expertise is able to compensate (especially if there is no practice), and the overall level of competence in the domain will decline.

Following the production function approach proposed earlier, the evolution of competence over the life course would result from the combined effect of all these constituent elements at each point in time. On this basis, we can represent a typical life course development of competence to be as follows:

The stage of highest competence growth is typically around the transition from education to work, when expertise also starts being accumulated.

Its peak typically occurs when expertise reaches its maximum, after a certain period of experience in the domain. At this point, skills and attitudes are also likely to be close to their highest, whereas knowledge is likely to have already declined for some time.

After this peak towards the second half of the career, the level of competence would typically start a very slow decline driven by dropping knowledge and skills but contained by continuing peak (or even growing) expertise; after retirement, the decline in competence would be steeper.

Figure 6 - An illustration of the development of competence over the life course

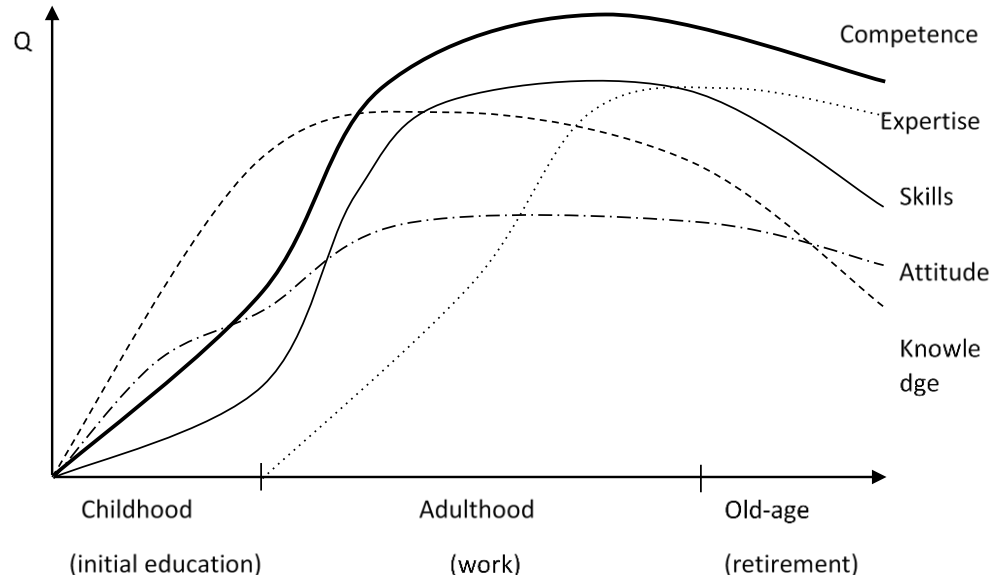


Figure 6 provides a stylised depiction of the evolution of competence and its components in a particular domain over the life course, to illustrate some of the ideas discussed so far. For instance, knowledge is mostly accumulated over the initial education period, peaking very early in adulthood and slowly declining over the work period because of growing specialisation. Skills, on the other hand, grow much more slowly before adulthood, because they are mostly acquired by practice in a particular domain, and they tend to peak around the middle of the career, declining more slowly (until retirement, when they would drop fast). Attitudes are difficult to represent (the metric reflects how attitudes contribute to competence in the domain), but we have tried to reflect the fact that in early childhood some of the key attitudes are acquired, and then the more domain-specific attitudes are acquired in the work period. Finally, expertise (corresponding to the efficiency term in our equation) would only start to grow in the work period, peaking around the time of retirement, and declining much less steeply afterwards. These different paths imply a different effect of the different stages of life on the development of overall competence. In the early years, competence would mostly grow because of knowledge accumulation, while in adulthood skills and expertise would be the main drivers. After the middle of the

career, the overall competence level would be mostly maintained by growing expertise, whereas skills and especially knowledge would tend to contribute negatively in these later years.

This description of the development of competence and its components is very general and purely illustrative, but it may apply broadly across domains or jobs, at least in cases where there is a relatively good match between initial education and the labour market, and thus some consistency in the process of competence development. In practice, the actual development of competences could depart from this ideal type in several ways. First, at the individual level, the specific timing of different evolutions will depend on genetic, nurture, and environment, as well as the opportunities to apply learning. Second, it can vary greatly across domains, depending on the weight that each component has in the formation of competence. For instance, some jobs require mainly practical skills rather than abstract knowledge (e.g., dexterity), in whose case competence development may follow more closely that of skills. Third and final, the development pictured in *Figure 6* assumes a prototypical life course with a highly consistent career, with initial education matching the adult occupation, and no significant spells of unemployment or periods of additional adult education. This stylised pattern may be fundamentally altered, by idiosyncratic external shocks driven by either demand or supply factors, or by an increase in lifelong learning. We elaborate some of these points in the next section.

The framework presented in this paper can also serve as a blueprint to develop indicators for monitoring skills and competence development at large. An ideal monitoring framework would require an ad-hoc longitudinal survey, following cohorts of people over their life course to measure the acquisition, development and use of skills and competences. In the absence of such a survey, in Annex B we show that some indicators already available in the European Statistical system can be used to measure some of the dimensions of the framework described in this paper.

5. Some additional illustrations

The conceptual framework presented in the previous pages provides consistent definitions and explicit hypotheses about the structure and relationships between the concepts of jobs, tasks, skills and competences. This framework tries to bring together concepts that are normally discussed separately, typically only from the point of view of supply (competences, skills) or demand (jobs, tasks). It also tries to incorporate those concepts into a life-course perspective that is particularly useful to discuss the development of competences over time. In this section, we present some illustrative applications of this framework to specific concepts or phenomena in the area of skills and human capital. In particular, we will discuss supply-side and demand-side effects in the development of competences that depart from the typical pattern discuss above, as well as the topic of mismatch between supply and demand of skills.

Supply-side factors

During the period of initial education and training, adolescents may follow a general/academic or a vocational type of education (VET). In both cases, students accumulate skills, knowledge and attitudes that are potentially useful for their careers. The main difference is that students in VET are trained for a specific profession and learn from hands-on situations. According to our conceptual framework, this would mean that students in general education and those in vocational education develop their competences differently. VET students immediately start accumulating skills and expertise for the job, and they start specialising in one domain earlier in life than those in general education. The accumulation (and importance) of general knowledge in the development of their competences would be lower than for those in general education.

During their careers, adults may decide to participate in further training or education. According to Cedefop (2014), adult learning is defined as "general or vocational education provided for adults after initial education and training for professional and/or personal purposes, and which aims to provide general education, provide compensatory learning in basic skills, give access to qualifications or acquire, improve or update knowledge, skills or competences is a specific field". Adults can also participate in education and training episodes, by their own initiative or through on-the-job training. These episodes aim at refreshing or expanding their skills, knowledge or attitudes, thus increasing their general competence[14]. Initiatives like the European Skills Agenda are developed to encourage this type of adult learning (e.g., the Upskilling Pathways program[15]). In our framework, adult learning would be illustrated by an upward shift in the skills, knowledge or attitudes curves, depending on the type of training followed.

Demand-side factors

On the demand side, it is important to note that the task contents of a job can substantially change during the life of individuals, which may render their initially accumulated competences inadequate for carrying out their tasks. For instance, the introduction of new technologies or a reorganisation of production or work can trigger a significant change in the task content of a job. In the conceptual framework, the impact of a significant change in the task contents of a job on the competence curve of the individual can be represented as a sudden drop in the relevant curves, to the extent that the stock of expertise, skills, knowledge or attitudes of the individual is not so relevant anymore for the job. It is important to remember that the competence curves represent the development of competence and its components for a particular task domain or job: if the task domain changes, the curves necessarily change as well. Periods of adult education or training can bring up the curves again, or experience; or the drop can have long-term effects on the competences of the worker.

Supply-Demand matching factors

Cedefop (2014) defines skills mismatch as the "situation of imbalance in which the level or type of skills available does not correspond to labour market needs." Following our framework, we would argue that the level at which the concept of mismatch should be discussed is at the level of competences relative to the jobs (and their associated tasks). Our concept would also imply that the mismatch can differently affect the components of competences, namely skills, knowledge or attitudes.

A specific case of mismatch is when the worker cannot find a job according to her initial education, i.e., a trained doctor has to work as a waiter because she cannot find any job as a doctor. In this case, the typical development illustrated earlier in *Figure 6* would not apply. We could picture this situation with two separate curves. The first case (underutilised competence) would be identical to *Figure 6* until the adulthood period, when the absence of any practical application of these competences would lead to a decline in skills and knowledge and no expertise accumulation; in other words, a decline in the overall competence curve from the adulthood period. Since the frustrated doctor would work as a waiter, she would develop the associated competences, which we could picture with a second set of curves. In this case, there would be no initial competence development before adulthood, because there was no training at all for the waiting profession. There would also be a steep accumulation of competence in the beginning of

[14] The terms up-skill or re-skill are commonly used, but here we refer to upgrade and increase competences as a whole.

[15] Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for Adults *OJ C 484, 24.12.2016, p. 1–6* .

the adult period (mostly of a practical skill nature), coinciding with the necessity of learning in the practice of a job for which there was no previous preparation.

6. Conclusions

There are two main motivations behind this paper. On the one hand, it tries to address the confusion and conceptual inconsistency that, in our view, is often found in policy documents and papers on the subject of skills and competences. On the other hand, it attempts to provide explicit concepts and links for bridging the analysis of the supply and the demand side of skills, in education systems and the labour market respectively. In our view, the acceleration of technical change in the economy associated with the digital revolution makes increasingly important to integrate the demand and supply perspectives in any analysis of skills and competences.

The cornerstone of our proposal is the strong and direct link that can be established between the concepts of task and skill: a skill is the ability to do a task well. On this simple basis, it is possible to establish a series of equivalencies between the supply and demand side of skills and tasks that provide the basic structure of our framework. The equivalency between tasks and skills also allows using task taxonomies to classify the corresponding skills in a very practical way.

In this framework, competence is a much broader concept than skill, because it implies being able to cope not only with a number of predefined tasks but also with uncertainty in a given domain. This uncertainty, which is an important element in all real-life employment contexts, is what explains the importance of the other elements – beyond skills – that make up competence: knowledge, attitudes, and expertise. The acquisition and development of competence, which in our proposal is always domain-specific, takes place throughout the life-course, with the different components growing or declining separately in different periods. Typically, initial education at a young age develops mostly the components of knowledge and attitudes, whereas skills mostly develop (and consolidate) with their application in an actual work context and expertise accumulates slowly with work experience. The overall level of competence of a person in a given domain at a given time is an aggregate function of these different components, and can be affected by different events such as a change in task content (for instance as a result of technical change) which can make some skills obsolete, career shifts or spells of adult education.

The framework proposed in this paper, thus, has a quasi-symmetrical structure that builds upon the basic equivalence between tasks and skills. On each side, tasks and skills cluster into domains. Since any domain can incorporate uncertainty in the undefined space that lies between its component tasks, these domains become the real-world concepts of job (as a particular task domain embedded in the division of labour of an economic organisation) and competence (as a general ability to do well in a given task domain).

As previously discussed, competences encompass other elements beyond skills. In this paper, we proposed a production function approach to operationalise this framework, with competence being a function of knowledge, skills and attitudes relevant to a given domain, with expertise added as an efficiency term since it entails a better use of the available cognitive resources, and which is acquired by long-term practice. This operationalisation can also be applied dynamically to the development of competence in a given domain over the life-course, as proposed in the last section of this paper with a number of illustrations.

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Annex

Annex A – Definitions of *competence* and *skills* in documents by the European Commission and the OECD

Source	Competence	Skill
Cedefop (2014)	Competence is the ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development) and is not limited to cognitive elements, but also encompasses functional aspects and interpersonal attributes and ethical values.	Ability to apply knowledge and use know-how to complete tasks and solve problems.
Key Competences for Lifelong learning	Competence are conceptualized as a combination of knowledge, skills and attitudes; where attitudes are dispositions and mind-set to act/react to ideas, persons or situations and also include values, thoughts and beliefs.	Ability and capacity to carry out processes and use the existing knowledge to achieve results
European Qualification Framework	Proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in a professional and personal development. Competence is described in terms of responsibility and autonomy.	Ability to apply knowledge and use know-how to complete tasks and solve problems. Skills are described as cognitive or practical.
ESCO[16][1]	The ESCO skills pillar distinguishes between i) skill/competence concepts and ii) knowledge concepts by indicating the skill type. There is however no distinction between skills and competences.	
Skills Panorama (Cedefop)	Proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development	Ability to apply knowledge, use know-how to complete tasks and solve problems and carry out tasks that comprise a particular job.

[16] ESCO - European Skills/Competences, Qualifications and Occupations https://ec.europa.eu/esco/portal)

OECD (1998)	The ability to use knowledge and skills appropriately in real-life contexts and situations. It is often conceived in terms of capacity to exercise responsibility and act autonomously.	The ability to apply knowledge and use know-how to complete tasks and solve problems. Classified into cognitive, technical, communication, interpersonal and intrapersonal
OECD (2002) DeSeCo project	Ability to meet demands of a high degree of complexity. It includes knowledge and skills but also strategies and routines needed to apply knowledge and skills, as well as appropriate emotions and attitudes and effective management of these components.	Ability to use one's knowledge with relative ease to perform relatively simple tasks.

Annex B – Monitoring tasks, skills and competences: some possible indicators

The conceptual framework presented in this paper provides a consistent definition of the key concept of *competence*, which is composed of four different elements: *skills*, *knowledge*, *attitudes* and *expertise*. These different components evolve over the life course of an individual as they are acquired, developed and deployed in education, work, and other aspects of life. As they evolve, they need to be measured consistently, to guide policymaking coordinate skills policy in initial education, vocational education, and on-the job training.

An ideal monitoring framework to measure skills, tasks, and competence over time would focus on individuals, following their development in education, in the transition to work, and throughout their professional life. Implementing this monitoring framework would involve developing a dedicated survey, combining standardised testing with qualitative self-assessment for skills, knowledge, attitudes and expertise. It would also measure the task content of occupations – what people do at work and the skills this requires – following the classification presented in this paper (see Figure 1).

Direct measures of skills and competences across countries are still scarce. The two international data sets that come closest to measuring these concepts are the Programme for International Student Assessment (PISA) and the Programme for the International Assessment of Adult Competencies (PIAAC), both developed by the OECD. PISA provides internationally comparable survey of students on a relatively narrow set of knowledge and skills, including language proficiency and numeracy. PIAAC is measures some skills used by adults at work and in everyday life – namely literacy, numeracy, computer skills, but offers little to no information on skills for social and physical tasks (see Box 2 below). The other important data source is the LFS, which provides national aggregate indicators for early-school leavers, unemployment, mismatch, expertise, among others.

Granular data on the skills required in the labour market is also very scarce at the European level. Ideally, we would like to know the precise tasks each worker performs (or is expected to perform) at work in each occupation. Some data on work organization and tasks can be found in international surveys such as the European Working Condition Survey (EWCS), conducted every five years by Eurofound, but the focus on working conditions only partially overlaps with the range of possible tasks described in the framework. PIAAC does contain survey information on whether employees are adequately skilled for their position, and whether they use the skills (literacy, numeracy, and digital) that they possess in their line of work. However, is mostly cross-section data and not available in all EU countries (see Fernández-Macias and Bisello, 2017).

To improve data on tasks and skills of occupations at the European level, we would suggest to complement the currently available data on tasks with data on job vacancies – and the descriptors of requirements therein, which provide the competences (and skills) sought by employers in real time. This could allow capturing the changing demand for skills by employers over time, by collecting the skills that they require in real time. Indeed, previous studies such as Deming et al. (2019) used it to track the changing requirement of skills across occupation groups in the U.S., while Tijdens et al. (2018) relied in part on it to quantify skill mismatches by occupations. The JRC has acquired pilot data for the UK from Burning Glass Technologies, a commercial provider, and is validating its suitability to act as an indicator of occupational tasks and skill demand. Cedefop is also currently testing its own data collection platform for European job vacancies, and the JRC is in talks to achieve a shared methodology. From an initial analysis of this type of data, it emerges that it also presents some disadvantages. First, the availability of online job vacancies varies by country, sector and occupation, which limits representativeness. According to Cedefop, the detail of content also changes considerably by European country and language, complicating international comparisons. Some sectors, such as the software industry and

healthcare, appear to be over-represented relative to their share of total occupation, which can only be partially explained by higher turnover in those sectors. Second, online vacancies inevitably provide a partial, one-sided perspective of the task and skills required for any given position. They emphasise the methods and tools of work – and related skills – especially knowledge of a specific software or technology, and refer less explicitly to other types of skills such as basic literacy or numeracy, which may only be required at an advanced level. This is to be expected from the aspirational type of communication use in vacancy notices, which will only explicitly mention the skills and competences that it cannot take for granted from a typical applicant, leaving basic skill requirements implicit. Moreover, vacancy notices provide limited objective task-related information of work organization, rarely mentioning the degree of control or (lack of) autonomy that employees in those occupations experience. Overall, online vacancy data can provide a valuable complement of a monitoring framework, by providing timely signals about emerging skills, but offer limited comparable data of skill use across occupations.

Box 2: What does PIAAC measure?

The Programme for the International Assessment of Adult Competencies (PIAAC) developed and conducted the Survey of Adult Skills. The OECD defines human capital as "the knowledge, skills, competencies and other attributes embodied in individuals that are relevant to economic activity" (OECD, 1998, p. 9). Skills are further classified into cognitive, technical, communication and interpersonal and intrapersonal skills. In spite of the pragmatic approach taken by the OECD, whereby "competencies" and "skills" are used interchangeably (OECD, 2013), the PIAAC skills assessment module measures mainly cognitive skills (literacy, numeracy and problem solving), and to a limited extent technical skills (via computer use) and knowledge (via the literacy and numeracy tests) (see OECD 2013, p. 101). The survey focuses on key skills needed for individuals to participate in society and for economies to prosper. It directly assesses adult proficiency in key information-processing skills – literacy, numeracy and problem solving in technology-rich environments – and gathers information on how adults use their skills at home, at work and in the wider community. Hence, from the perspective of our conceptual framework, the PIAAC assessment module captures mainly transversal skills, rather than competences as defined. It also overlooks the physical and social skills, described in Section 3 of this paper. Physical skills relate to physical tasks, involving strength or dexterity. Social skills relate to proficiency in tasks such as attending, teaching, influencing or managing.

In the absence of unified data sources to implement this monitoring framework, we compile a set of existing indicators that shed some light on tasks, skills and competences. Table 1 lists these indicators, reports their source, explains the reason for their inclusion, and reports the frequency with which they are collected. Taken together, they can help shed some light on the state of skills development and use in the European Union, and can be used to benchmark country performance and at guide and monitoring competence development policies. However, they are imperfect surrogates of a dedicated longitudinal survey: most of them capture a snapshot of single life stages (like education or transition to employment) and tend to describe cross-sectional national aggregates, rather than the evolution of individuals in cohorts. Although there are indicators covering all main aspects of the framework, they are not all collected as frequently.

Annex C lists and briefly describes other existing skills monitoring frameworks. Compared to these other frameworks, the conceptual framework for tasks, skills and competences presented in this document seems better suited to the needs of policy-making. It is also the only one directly contemplating tasks and skill demand (WISE being the only one that considers tasks). More importantly, our proposal is unique in integrating the tasks and

skills perspectives and in taking an explicit lifecycle perspective, which helps in coordinating the skills policies across stages of life that make up skill ecosystems.

By adopting a lifelong perspective, the proposed monitoring framework would allow to identify problems in competence development at different stages of life. This is relevant to identify problems during adolescence before students enter the labour market, such as a lack of basic skills because this will compromise future competence development. It can also be useful to identify and target the segment of the labour force that may need re-skilling or up-skilling activities, in terms of either demographics, geography, occupation or industry. Updating the monitoring framework at different points in time would help identify the most relevant changes in the area of tasks, skills and competences. For instance, the changes in tasks (skills used at work, or sought after by employers) provide valuable information on the change in skills needs – in terms of both skill obsolescence and the appearance of new types of skills – which will allow skills development systems to change accordingly.

Table 1: Details of selected indicators for stage-specific aspects

Childhood & Adolescence (Initial E&T)					
Area	Indicator	Description	Rationale	Source	Periodicity
Competence acquisition	Early-school leavers (ESL)	Share of population aged 18-24 that have not completed upper-secondary school and is not enrolled in education	Share of young adults that left education without the minimum requirements	LFS (18-24 years old)	Yearly
Type/level of studies	VET in upper-secondary (VET_US)	Share of students in upper-secondary school attending VET programs	Type of studies being taken by students in upper-secondary	OECD, Eurostat, UNESCO joint data collection	Yearly

School-to-work transition (Initial E&T)					
Area	Indicator	Description	Rationale	Source	Periodicity
Competence use	Employment of recent graduates	Share of population aged 20-34 that have graduated within the last three (or five) years and are employed	Share of recent graduates that are working, hence applying competence.	LFS	Yearly
Competence use	Mismatch_SWT	Share of recent graduates that are over-qualified in their current job	Share of recent graduates that are working, but in less demanding jobs that the ones they were trained for, hence not making use of the recently acquired	LFS	Yearly

			competence.		

Adulthood/Work life					
Area	Indicator	Description	Rationale	Source	Periodicity
Competence acquisition	Adult learning	Share of population aged 25-64 who stated they received formal or non-formal training in the 4 weeks preceding the survey	Share of adults that are acquiring competence in episodes specifically with that purpose.	LFS	Yearly
Type/level of competences	Tertiary degree	Share of the population holding a university degree	Provides a proxy of the stock of complex skills hold by the adult population.	LFS	Yearly
Type/level of competences	VET	Share of the population with a VET-oriented education degree	Share of the population that has been trained for a specific profession	LFS	Yearly
Type/level of competences	Expertise	Average time working for the same employer	Proxy for expertise, that would be better captured by the time working in the same occupation	LFS	Yearly
Competence use	Skills_everyday	Share of the population using specific skills in everyday life	Reflects the skills used in everyday life and hence being developed.	PIAAC	Once (mainly 2013)

Competence use	Skills_work	Share of the population doing specific tasks at work	Reflects the skills used at work and hence being developed.	PIAAC	Once (mainly 2013)
Competence use	Long-term unemployment	Share of the labour force unemployed for at least one year	Share of labour force that is not putting in use the competences at work	LFS	Yearly
Competence use	Mismatch	Share of employed individuals overqualified for the job	Share of employed individuals that are working in less demanding jobs, hence not fully taking using the competences they have.	LFS	Yearly

Table 2: Details of selected indicators for aspects relevant throughout the lifecycle

Childhood & Adolescence (Initial E&T)					
Area	Indicator	Description	Rationale	Source	Periodicity
Skills levels	PISA skills	Average score in PISA, different subjects	Stock of basic and transversal skills/competences	PISA (15 years old)	2000, 2003, 2006, 2009, 2012, 2015. (2018 soon)
Skills levels	Low achievers in PISA		Share of 15 year sold with insufficient basic skills/competences	PISA (15 years old)	2000, 2003, 2006, 2009, 2012, 2015. (2018 soon)

Adulthood/Work		

Area	Indicator	Description	Rationale	Source	Periodicity
Skills levels Skill levels	Adult skills (transversal subjects, PIAAC)	Average score of adult population in PIAAC subjects	Provides a better proxy of transversal competences: literacy, numeracy and problem-solving in technological-rich environments.	PIAAC	Once (mainly 2013)
Skills levels	Low achievers (transversal subjects, PIAAC)	Share of adults with insufficient levels of transversal skills.	Provides a measure of the share of the adult population that has low levels of transversal skills and that may need up-skilling actions.	PIAAC	Once (mainly 2013)
Skills demand by employers	Own elaboration from Cedefop data	Types of skills required, by occupation or job title	Provides a partial but useful measure of the skills that employers are currently demanding	Cedefop (soon)	Continuous
Tasks at work	Own elaboration from Cedefop data	Types of tasks mentioned, by occupation or job title	Provides a partial but useful indication of the types of tasks that employees perform in different occupations.	Cedefop (soon)	Continuous

Annex C – A brief overview of existing skills monitoring frameworks

Education and Training 2020 Strategy (DG EAC)

"Education and Training (2020) is a strategic framework for European cooperation in education and training. It provides common strategic objectives for EU member states, including a set of principles for achieving these objectives, as well as common working methods with priority areas.

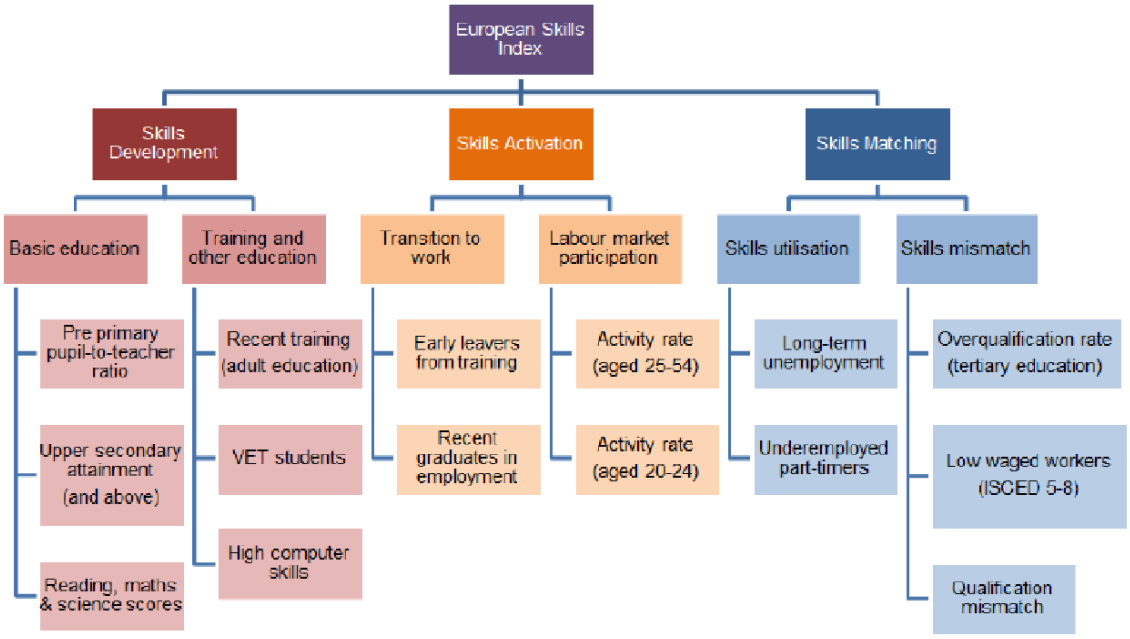
There are six objectives described in the following benchmarks for 2020:

1. *Early leavers from education and training*: The share of early school leavers from education and training aged 18 to 24 should be less than 10%;
2. *Tertiary education attainment*: By 2020, the share of 30-34 years old with tertiary educational attainment should be at least 40%.
3. *Early childhood education and training*: At least 95% of children between 4 years old and the age for starting compulsory education should participate in childhood education.
4. *Employment rate of recent graduates*: The share of employed graduates (20-34 years old) having left education and training no more than three years before the reference year should be at least 82%.
5. *Low achievers in reading, mathematics and science*: The share of 15 years old with insufficient abilities in reading, mathematics and science should be less than 15%.
6. Learning mobility
    - An EU average of at least 205 of higher education graduates should have had a period of higher education-related study or training (including work placements) abroad, representing a minimum of 15 ECTS credits or lasting a minimum of three months.
    - An EU average of at least 6% of 18-34 years old with an initial vocational education and training (IVET) qualification should have had an IVET-related study or training period (including work placements) abroad lasting a minimum of two weeks, or less if documented by Europass.

European Skills Index (Cedefop)

The European Skills Index (ESI) is developed by Cedefop. It has three pillars to assess how well the skills formation and matching systems of EU MS are performing in relation to the degree to which they are developing, activating and matching skills reserves within their economies. The ESI focuses on these supply and matching aspects of the skills system.

Each pillar is broken down further into sub-pillars to further organise the indicators into related groups. In total, ESI has 3 pillars, 6 sub-pillars and 15 indicators.



Eurostat

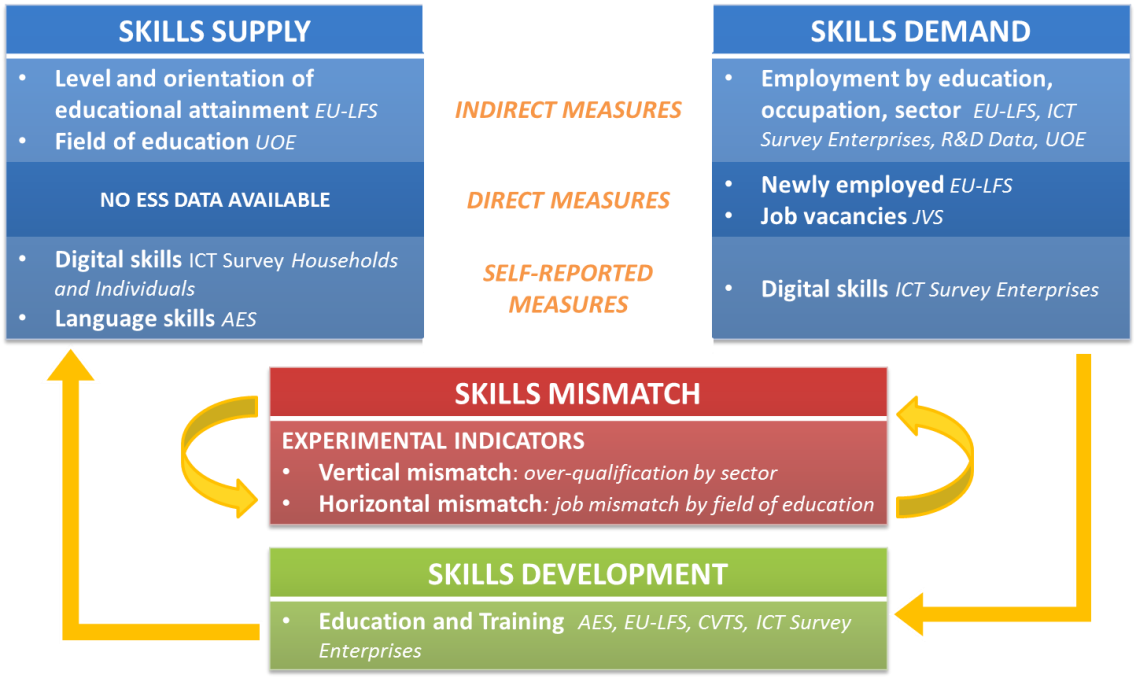
The Eurostat dataset on skills-related statistics contains indicators originating from multiple data sources which focus on the following topics:

- **skills supply** (the existing skills of the labour force);
- **skills demand** (the skills needed by employers);
- **skills development** (the skills developed by participation in education and training activities).

Skills supply and skills demand are measured through three different approaches:

- **indirect measures**, for instance skills assumed to be acquired through formal education;
- **direct measures**, which are direct assessments of skills through e.g. test scores for skills supply;
- **self-reported level of skills**, that is people's self-evaluations of skills.

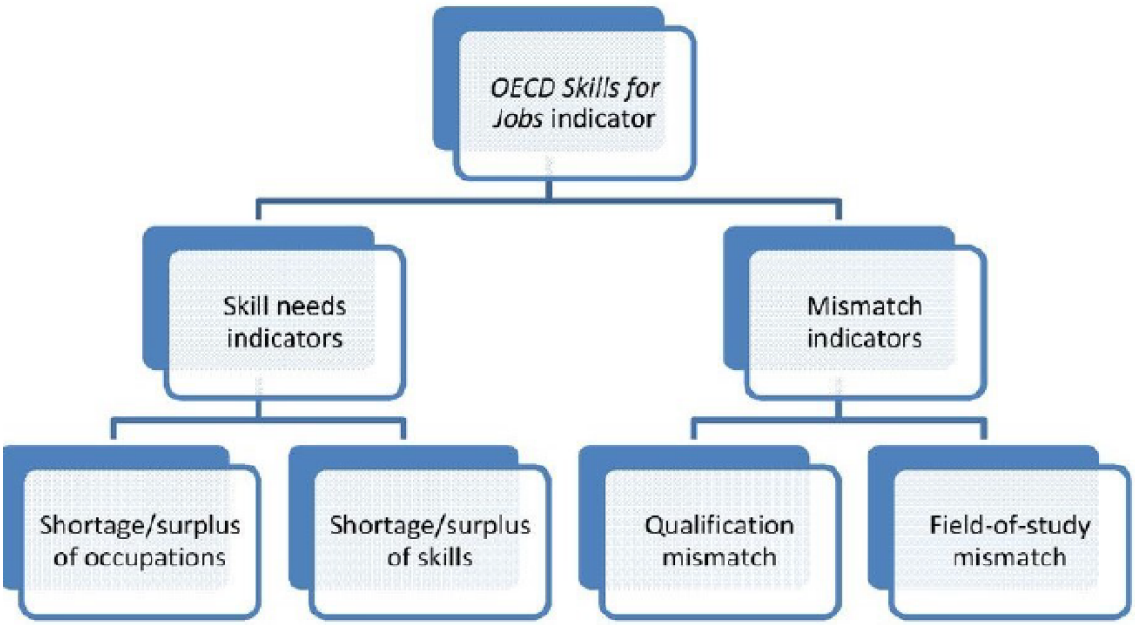
Eurostat´s Conceptual Framework on skills along with the different measurement approaches:



Getting Skills Right: Skills for jobs indicators (OECD)

Based on O*NET database descriptors, OECD (2017) measures mainly skills needs and mismatch indicators. The indicators on skills needs include a mapping of the shortage or surplus for three domains of competence: skills, knowledge and abilities.

The structure and components of the OECD Skills for Jobs Indicators:

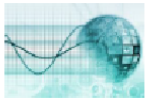


World Indicators of Skills for Employment (OECD)

The WISE database provides a statistical snapshot of skills development in 214 countries. It contains 64 indicators in five broad areas:

- contextual factors
- skill acquisition

- skill requirements
- skill mismatch
- economic and social outcomes



Source: OECD, Skills for Employment Indicators

Glossary and references

ECTS: European Credit Transfer and Accumulation System. https://ec.europa.eu/education/resources-and-tools/european-credit-transfer-and-accumulation-system-ects_en

ESCO: European Skills, Competences, Qualifications and Occupations. https://ec.europa.eu/esco/portal/home

ESI: European Skills Index (Cedefop). https://skillspanorama.cedefop.europa.eu/en/indicators/european-skills-index

EWCS: European Working Conditions Survey (Eurofound): https://www.eurofound.europa.eu/surveys/european-working-conditions-surveys

IE&T: Initial Education and Training

KCLLL: Key Competences for Lifelong Learning. https://op.europa.eu/en/publication-detail/-/publication/297a33c8-a1f3-11e9-9d01-01aa75ed71a1

LFS: (European Union) Labour Force Survey. https://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey

PIAAC: Programme for the International Assessment of Adult Competencies (OECD). https://www.oecd.org/skills/piaac/

PISA: Programme for International Student Assessment (OECD). https://www.oecd.org/pisa/

O*NET: Occupational Information Network (US Department of Labor): https://www.onetonline.org/

STW: School-to-Work transition.

(I)VET: (Initial) Vocational Education and Training

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