

Set of competences targeted by the train-the-trainer programme

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Abbreviations

BYOD	Bring Your Own Device
Cedefop	European Centre for the Development of Vocational Training
CEFR	Common European Framework of Reference for Languages
DG EAC	Directorate General for Education, Audiovisuals and Culture
DG EMPL	Directorate General for Employment, Social Affairs and Inclusion
DigComp	Digital Competence Framework for citizens
e-CF	e-Competence Framework
ECVET	European credit system for vocational education and training
EQAVET	European quality assurance in vocational education and training
EntreComp	Entrepreneurship Competence Framework
EQF	European Qualifications Framework
ESCO	European multilingual classification of Skills, Competences, Qualifications and Occupations
EU	European Union
GDPR	General Data Protection Regulation
HVET	Higher Vocational Education and Training
I4.0	Industry 4.0
ICT	Information and Communication Technology
IoT	Internet of Things
IPR	Intellectual Property Rights
IR4	Fourth Industrial Revolution
IT	Information Technology
JRC	Joint Research Centre
KSA	Knowledge, skills, attitudes
MOOC	Massive Online Open Course
OER	Open Educational Resources
PBL	Project-based learning
PDCA	Plan-Do-Check-Act
PoC	Proof of concept
VET	Vocational Education and Training
XPM	Extreme Project Management



Foreword

“Fit for 4.0: training trainers and teachers for the 4.0 paradigm” is a project co-funded by the European Commission in the framework of the Erasmus+ Programme. Its goal is supporting teachers and trainers in the transition towards the new learning paradigm required by the digital transformation and the fourth industrial revolution.

Industry 4.0, digital revolution, smart factories, global interconnection – these are the keywords describing the present developments of the labour world. Vocational training can become “the first choice” to live this transformation, but at present only a few training centres in Europe can exploit necessary equipment and, even more important, teachers and trainers are not aware of the dimension of such changes, or can exploit the required tools (conceptual and methodological first, rather than technological). Some of them tend to focus on teaching rather than on learning; some are not fully aware of existing on-line tools for learning, teaching, assessing; some do not interact with each other as much as they could, thinking they have know-how to “defend”; some need a clearer picture of the nature, implications and real meaning of the 4.0 paradigm, which is not only “Industry” 4.0 and technology, but also involves the whole society.

In order to make VET sustainable, it is relevant updating its times and tools, favouring collaboration among teachers/trainers, learners, training providers, companies, social parts, local authorities.

Fit for 4.0 intends to take this challenge, by describing a set of competences useful to Vocational Education and Training (VET) teachers, and by developing and testing a set of training modules fit for “4.0”, in strict co-operation with companies.

Fit for 4.0 is performed by a strong consortium of 10 partners in 8 EU Member States: Italy, Austria, Belgium, Denmark, Finland, Portugal, Sweden, the United Kingdom, representing a competent and skilled mix of excellent European VET players, in the spirit of providing for a true “strategic partnership”.

This document is the first project output, presenting the list and description of competences teachers and trainers should possess to adequately facilitate learners in the development of their 4.0 skills. Such competences will be targeted by the subsequent train-the-trainers programme. This document reports:

- the national surveys carried out by partners to identify and select relevant competences;
- the list of competences to be targeted by the subsequent train-the-trainers programme;
- the template for competence description (e.g. in terms of knowledge, skills, attitudes, autonomy, responsibility, etc., of category – cross-, sectoral, etc. – and of level – basic, intermediate, advanced, etc.).

1. The project Fit for 4.0

Rationale

The project follows a three-step development pathway.

Step 1, based on existing studies and direct experiences collected from teachers in the partner Countries about changes brought by Industry 4.0, aims at:

- describing and highlighting competences necessary to trainers, with special reference to the mechanic/mechatronic/automotive sectors, having in mind ICT skills as the engine for the “4.0 world”. The focus is mostly on cross/soft skills, in addition to the professional ones that teachers already possess or can more easily develop.
- Delivering an on-line tool, allowing trainers to self-assess their readiness to handle and embed 4.0 topics in their daily work.

Step 2 designs and tests a train-the-trainers programme, structured in Training Units based on learning outcomes, with a pervasive and “intelligent” usage of IT tools. The programme will be developed in co-operation with local industry associated partners, especially as to learning objectives, and will include for example:

- the 4.0 paradigm: the scenario underlying the value creation chain for goods and services, in a globally interconnected environment;
- key enabling technologies for 4.0: chances, implications, didactics;
- how to design “4.0 learning experiences”: planning, instructional design;
- 4.0 as a multi-disciplinary topic: how to embed 4.0 in all subjects, how to make trainers co-operate;
- co-design with companies: how to improve co-operation among teachers, trainers, enterprises;
- joint learning assessment by trainers and companies, including assessment of informal and non-formal learning;
- how to keep oneself up-to-date with the evolution of 4.0.

All topics will convey into a Massive Online Open Course (MOOC), including exercises, video clips, quizzes and research material.

Step 3 aims at ensuring mainstreaming and impact of results in partner territories. Trainers in the sample group will exploit outcomes in their day-by-day activities, by reviewing/setting part of/full programmes based on lessons learnt. Trainers and trainees in partner territories will participate in a friendly contest, competing to deliver best practices. Effectiveness will be assessed together with associated partners and results collected in guidelines, including also histories describing cases emerging from the contest.

Objectives

Project objectives are:

- describing a “minimum” of skills, namely didactical and transversal, needed by teachers/trainers, especially those involved in Higher Vocational Education and training (HVET), with regard to the 4.0 transition;
- developing a competence self-assessment tool, allowing VET teachers/trainers to measure their readiness for the 4.0 world and digital transformation;
- developing and testing, in strong cooperation with enterprises, a resource pack for trainers, a training programme delivered as a MOOC (Massive Online Open Course), complete with examples of training material, methods for learning assessment, innovative tools for training and learning;
- exploiting that MOOC to train a sample group of trainers, who will pilot their learning by co-designing training modules/programs in this new 4.0 concept, together with businesses;
- making such products available to everyone, even beyond the partnership, through a knowledge base of Open Educational Resources (OER) freely accessible via the same on-line platform used by the sample group;
- identifying a set of policy recommendations/suggestions to local, national and European decision-makers, for future updating of teachers’ and trainers’ competences.

To ensure concreteness, the project focusses on the mechanic, mechatronic and automotive sectors, where advanced digital competences are necessary, the digital revolution is already started, and meaningful company experience is in place.

The train-the-trainer programme aims mostly at improving skills for teaching, using innovative methods and tools, embedding the 4.0 paradigm in day-by-day work. That is why it relates to topics like understanding the sense and the impact of the 4.0 paradigm on study and work, or how to develop and run interdisciplinary 4.0 learning experiences together with colleagues and companies, how to make use of training methods mirroring operational processes at the workplace, how to assess competences in the digital era, and so on.

This train-the-trainer programme is practical and at the same time “intrinsically digital”, built up with the same instruments it offers, that is, by transnational teams composed by trainers and company experts, making use of on-line cooperative platforms.

Trainers taking the programme will learn by visiting companies, by discussing with peers (even at distance), by exploiting Design Thinking and Instructional Design techniques, by exchanging views with experts and professionals, and by "seriously" playing.

Main expected results are:

- more skilled VET teachers and trainers;
- improved quality of learning, hence better employability of students and attractiveness of VET;
- increased and stable cooperation between training providers, teachers/trainers and enterprises;
- availability of sustainable tools, transferable to other economic sectors and other European countries.

Figure 1 at next page synthesizes the project concept and model.

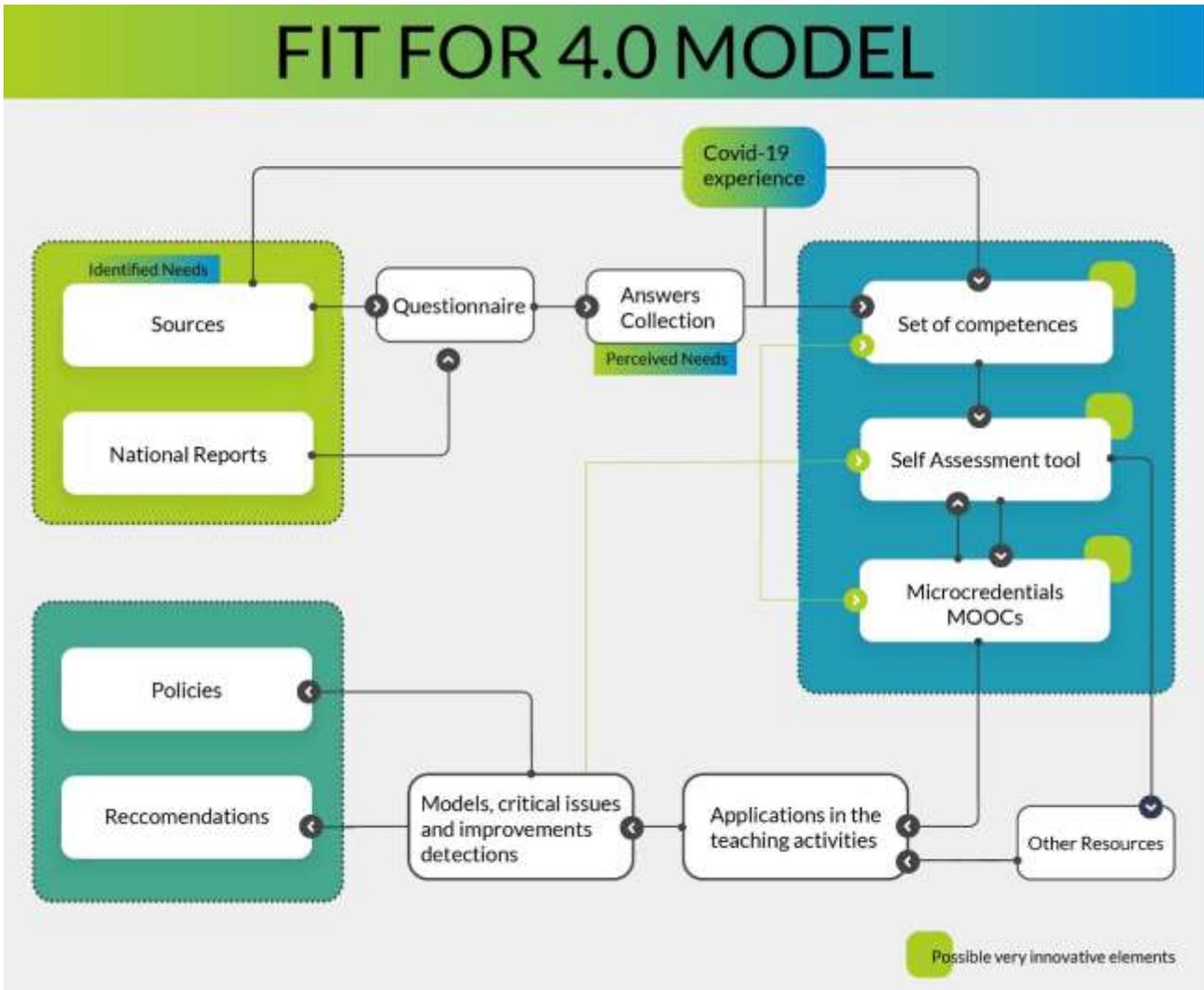


Figure 1 - The Fit for 4.0 model

2. Background

2.1. Industry 4.0 and the fourth industrial revolution

The term "Industrie 4.0", shortened to I4.0 or simply I4, originated in 2011 from a project in the high-tech strategy of the German government, which promoted the computerization of manufacturing¹ to mitigate the increasing competition from overseas and to differentiate German and European Union industries from other international market. Several definitions were proposed for Industry 4.0, and analysing them is beyond the scope of this output. We may say that Industry 4.0 is a name for the current trend of automation and data exchange in manufacturing technologies, including cyber-physical systems, the Internet of things, cloud computing and cognitive computing and creating the "smart factory". Several authors agree in saying that Industry 4.0 is about integrating nine familiar concepts used in industries, especially in manufacturing (figure 2).

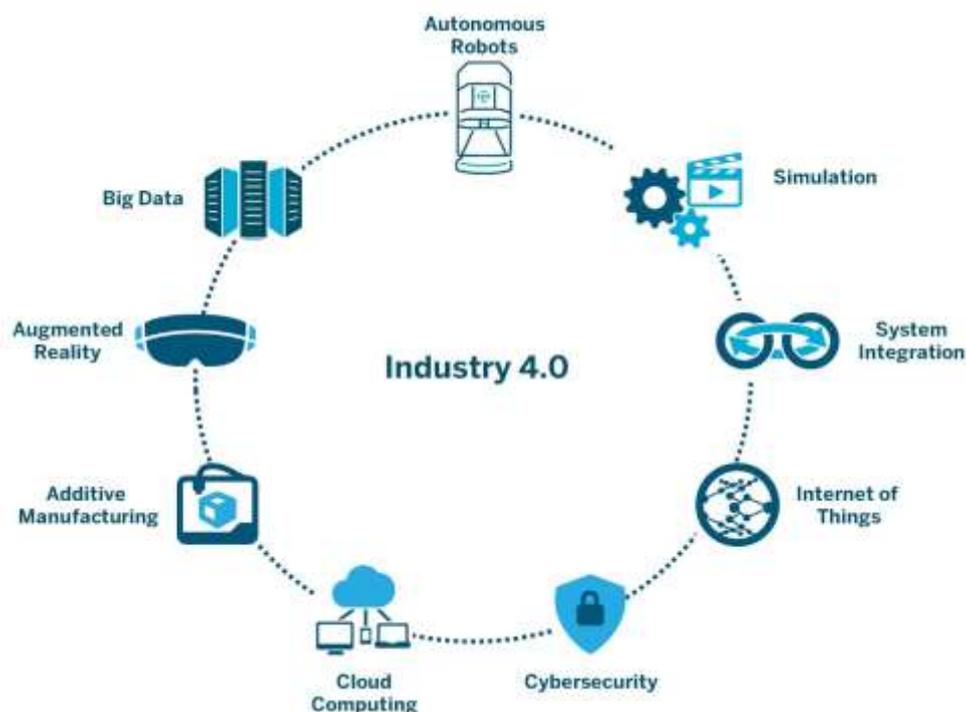


Figure 2 - The nine pillars of Industry 4.0²

Born as a strictly manufacturing-oriented term, Industry 4.0 quickly gained a broader meaning, witnessing the digital transformation of manufacturing/production and related industries and value creation processes.

¹ BMBF-Internetredaktion (2016). "Zukunftsprojekt Industrie 4.0 - BMBF". Bmbf.de. Retrieved from <https://www.bmbf.de/de/zukunftsprojekt-industrie-4-0-848.html>

² A. Melanson, "Robotics and Industry 4.0 - Aethon Blog", 2015. [Online]. Available at: <http://www.aethon.com/industry-4-0-means-manufacturers/>

Hence, the phrase “Fourth Industrial Revolution” (IR4.0) was first introduced by Klaus Schwab, the executive chairman of the World Economic Forum, in 2015³. The term describes a world where individuals move between digital domains and offline reality with the use of connected technology to enable and manage their lives. The term also makes reference to the “classic” industrial revolutions our society underwent in the past centuries (figure 3).

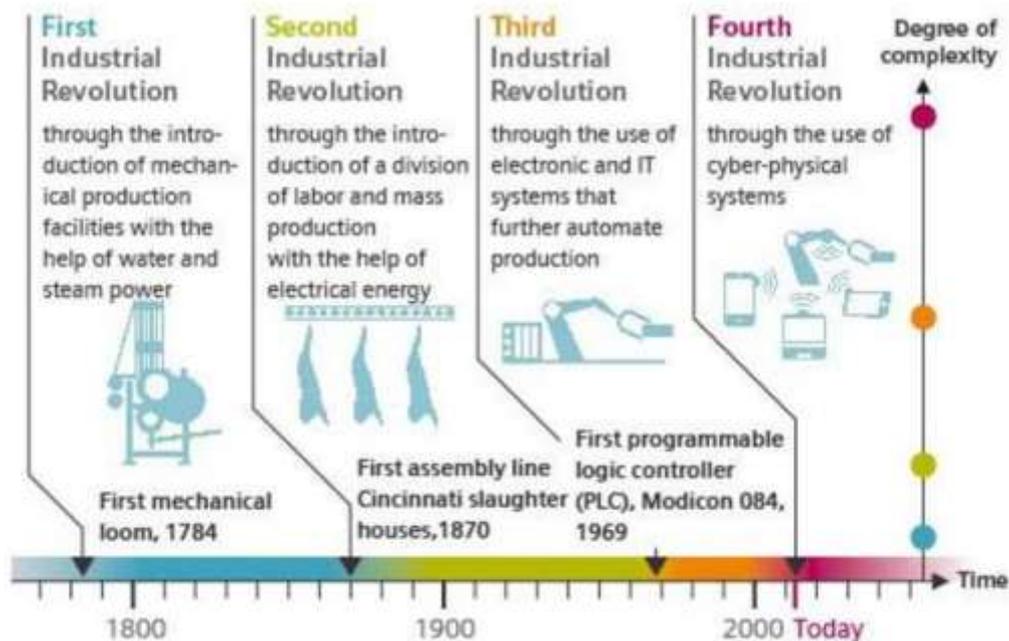


Figure 3 – Industrial revolutions⁴

2.2. Competences required for the fourth industrial revolution

The advancement of new technologies in the fourth industrial revolution blurs the lines between the physical, digital and biological worlds. These advancements are led by the emergence of artificial intelligence, robotics, the internet of things, autonomous vehicles, bio and nanotechnology, 3-D printing, material science, quantum computing and energy storage⁵.

However, IR4.0 is not only technology: it includes as well the digital transformation of the whole business. This implies that we have to rethink a) the digitization and integration of vertical and horizontal value chains and b) of the business model in general by optimizing the

³ Schwab, K. (2015). The Fourth Industrial Revolution: what it means, how to respond. Retrieved from <https://www.foreignaffairs.com/articles/2015-12-12/fourth-industrial-revolution>.

⁴ Source: Siemens AG, Pictures of the future, Spring 2013.

⁵ Diwan, P. (2017). Is Education 4.0 an imperative for success of 4th Industrial Revolution? Accessed from <https://medium.com/@pdiwan/is-education-4-0-an-imperative-for-success-of-4th-industrial-revolution-50c31451e8a4>

customer interaction and access.⁶ The disruptive nature of Industry 4.0 brings about considerable changes in work processes, which consequently requires a different approach to the way work is performed. New skills sets are required to perform existing and new jobs that emerge owing to Industry 4.0 technological advances.⁷ It is widely acknowledged that, although the skills required in different industries might differ, there are similarities in the competences required in different fields.

A significant number of authors state that strong social, collaborative skills will be as important as technical skills in the future.⁸ More, the interaction with intelligent machines will require a firm base of soft skills, such as emotional intelligence, critical thinking, innovation, communication, collaboration, leadership, and teamwork,⁹ also considering that intelligent machines cannot (yet) apply common-sense reasoning; neither can they show empathy, which humans need to do to increase productivity when working in smart factories.¹⁰ In other words, the best talent is not the machines but a combination of both humans and machines. Education and training institutions must strive to supplement theoretical knowledge with practical skills, social skills and responsibility, ethics and values, and entrepreneurship capability, among others,¹¹ not to forget learning and innovation skills, information technology skills, and life and career skills.¹² Technical training must not focus only on specific discipline knowledge; behavioural skills must also receive significant consideration, as well as interdisciplinary understanding. Furthermore, the sudden and impactful advances of Industry 4.0 technologies require employees to possess life-long learning capabilities.¹³ Other sources quote among the top soft skills required in an Industry 4.0 era creativity, emotional intelligence, and proactive thinking, agility in problem solving, the ability to reshape processes, etc.¹⁴

2.3. From Industrial Revolution 4.0 to Education 4.0

The wide and still unsettled scenario described in the previous paragraph brings to the evidence that the IR 4.0 affects not only the business, governance and the people, but also affects education.

⁶ Fitsilis, Tsoutsas, Gerogiannis (2018). Industry 4.0: required personnel competences. In International Scientific Journal "Industry 4.0", year III, issue 3, p.p. 130-133 (2018). Accessed from:

<https://stumejournals.com/journals/i4/2018/3/130.full.pdf>

⁷ World Economic Forum (2016). The future of jobs: Employment, skills and workforce strategy for the fourth industrial revolution. Global Challenge Insight Report, World Economic Forum, Geneva.

⁸ Gudanowska, A.E., Alonso, J.P. and Törmänen, A. (2018). What competencies are needed in the production industry? The case of the Podlaskie Region. Engineering Management in Production and Services, 10(1): pp. 65-74.

⁹ Wilson, J.H. and Daugherty, P.R. (2018). Collaborative Intelligence: Humans and AI are joining forces. Harvard Business review, Brighton, Issue Number: July-August, pp. 114-123.

¹⁰ Guszczka, J., Lewis, H. and Evans-Greenwood, P. (2017). Cognitive collaboration: Why humans and computers think better together. Deloitte Review, 20: pp. 8-29.

¹¹ Selamat, A., Taspir, S.H., Puteh, M. et al., R.A. (2017). Higher education 4.0: Current status and readiness in meeting the Fourth Industrial Revolution Challenges. Redesigning Higher Education towards Industry, 4: pp. 23-24.

¹² Venkatraman, S., de Souza-Daw, T. and Kaspi, S. (2018). Improving employment outcomes of career and technical education students. Higher Education, Skills and Work-based Learning, 8(4), pp. 469-483.

¹³ Prifti, L., Knigge, M., Kienegger, H. and Krcmar, H. (2017). A competency Model for "Industrie 4.0" Employees. In 13th International Conference on Wirtschaftsinformatik (WI). St. Gallen, Switzerland, pp.46-60.

¹⁴ Cotet, G.B., Balgiu, B.A. and Zaleschi, V.C. (2017). Assessment procedure for the soft skills requested by Industry 4.0. MATEC Web of Conferences, 121, pp. 07005

To be effective in Industry 4.0, education and training institutions should promote novelty in methods of acquiring and using knowledge. Collaboration between industry and institutions of higher learning should be fostered to promote the solving of real world problems. Traditional subjects should be blended with technical specialisation and project-based learning. The primary object should be to ensure that learners find relevance in what they are studying. Interdisciplinary training, massive open learning, and personalised learning will be experienced. Technological advancement is happening fast; thus institutions of learning must adapt to match innovation cycles.¹⁵ The Industry 4.0 era demands high cognitive abilities, which requires transformation in the higher education and training systems. The open education system is slowly taking over, so Higher Education and Training institutions might need to realign their business model to accommodate the open market.¹⁶

To make such changes explicit, the name Education 4.0 came to existence, as a response to the needs of IR4.0. This new vision of learning promotes learners to learn not only skills and knowledge that are needed but also to identify the source to learn these skills and knowledge. Learning is built around them as to where and how to learn and tracking of their performance is done through data-based customization. Peers become very significant in their learning. They learn together and from each other, while the teachers assume the role of facilitators in their learning.

According to Fisk¹⁷, there are nine trends related to Education 4.0:

1. Learning can be taken place anytime anywhere. e-Learning tools offer great opportunities for remote, self-paced learning. Flipped classroom approach also plays a huge role as it allows interactive learning to be done in class, while the theoretical parts to be learned outside the class time.
2. Learning will be personalized to individual students. They will be introduced to harder tasks only after a certain mastery level is achieved. More practices will be provided if the instructors see a need in it. Positive reinforcements are used to promote positive learning experience and boost students' confidence about their own academic abilities.
3. Students have a choice in determining how they want to learn. Although the learning outcomes of a course are preset by the institutions/bodies in charge of the curriculum, students are still free to choose the learning tools or techniques that they prefer. Among the options that lecturers can adopt to enable students to be creative in their learning are blended learning, flipped classroom and BYOD (Bring Your Own Device) approach.
4. Students will be exposed to more project-based learning. Students are required to apply their knowledge and skills in completing a couple of short term projects. By involving in the projects, they are practicing their organizational, collaborative and time management skills, which are useful in their future academic careers.
5. Students will be exposed to more hands-on learning through field experience such as internships, mentoring projects and collaborative projects. The advancement of the technology enables the learning of certain domains effectively, thus making more room for acquiring skills that involve human knowledge and face-to-face interaction.

¹⁵ Selamat, A., Taspir, S.H., Puteh, M. et al., R.A., op. cit.

¹⁶ Peters, M.A. (2017). Technological unemployment: Educating for the fourth industrial revolution. *Educational Philosophy and Theory*, 49(1), pp.1-6.

¹⁷ Fisk, P. (2017). Education 4.0 ... the future of learning will be dramatically different, in school and throughout life. Retrieved from <http://www.thegeniusworks.com/2017/01/future-education-young-everyone-taught-together>

6. Students will be exposed to data interpretation in which they are required to apply their theoretical knowledge to numbers and use their reasoning skills to make inferences based on logic and trends from given sets of data. The manual part of mathematical literacy will become irrelevant as computers will perform the statistical analysis and predict the future trends.
7. Students will be assessed differently and the conventional platforms to assess students may become irrelevant or insufficient. Students' factual knowledge can be assessed during the learning process, while the application of the knowledge can be tested when they are working on their projects in the field.
8. Students' opinion will be considered in designing and updating the curriculum. Their inputs help the curriculum designers maintain curriculum contemporariness, up-to-date and usefulness.
9. Students will become more independent in their own learning, thus forcing teachers to assume a new role as facilitators who will guide the students through their learning process.

These nine trends of Education 4.0 shift the major learning responsibilities from the instructors to the learners. Instructors should play their roles as directors of a complex learning process and as learner motivators to support the transition and should never consider it a threat to the conventional teaching profession.¹⁸

¹⁸ Anealka, A.H. (2018). Education 4.0 Made Simple: Ideas For Teaching, in International Journal of Education & Literacy Studies, vol. 6 issue 3.

3. Intellectual Output 1 – part 1: the survey

3.1. Aim and scope

We have seen that existing studies about changes expected with 4.0, as well as national policies in partner countries, state that the “upskilling” of teachers and trainers should occur in a number of domains. They also pay special attention to cross/soft skills, that is, those required in any sector in addition to professional skills that teachers and trainers already possess. In fact, the gap of specific technical skills can be bridged more easily even on an individual basis. On the opposite, a deep understanding of the nature of the 4.0 revolution is still missing, like the ability to embed it in one’s daily activities and live it as a “normal” part of one’s profession. Hence, this output focusses on cross skills.

The aim of this output is to identify and describe competences that teachers and trainers should possess to adequately facilitate learners in the development of their 4.0 skills. The subsequent train-the-trainers programme, to be developed at a further stage in the project, will target such competences.

To avoid the pitfall of a too broad, and therefore superficial, survey, partners agreed upon a number of assumptions, as follows.

- a. Teachers and trainers, depending on national regulations, possess at least one qualification entitling them to perform as such. In other words, this output builds on an existing base of competences, took for granted and somehow considered to be “naturally” in the backpack of teachers and trainers, at their respective levels.
- b. Point a. also implies that teachers and trainers know subjects they teach and are able to keep themselves up-to-date with the developments of their disciplines.
- c. Even if the fourth industrial revolution is strictly linked to technology, due to the reasons explained in previous chapters, this work will consider teachers and trainers neither as experts of last technology innovations nor as experimenters of captivating didactic methodologies. Rather, we address professionals who perceive the responsibility innate in their role, that is, facilitating their learners in growing up, by providing them with all intellectual, cognitive, technical, linguistic, behavioural and ethical tools required by the labour market and adult life. In other words, this work focusses on teachers’ and trainers’ didactic and personal skills, rather than on technology.
- d. Given their nature and goals, partners are interested in learning programmes covering only certain EQF levels, namely levels 4, 5 and 6. Other EQF levels fall outside the scope of this output.
- e. Partners are well aware that EQF levels (especially levels 4 and 5) can correspond to different kinds of training programmes and courses, depending on Member States and on National Qualification Frameworks. By choosing to stick to the EQF, partner intend to confirm the European value of this work, and to set its scope and boundaries.
- f. Even with the assumption made at point d., yet there are differences between teachers performing at the chosen EQF levels. Partners are well aware of that, and will take it into due consideration whenever possible, within the limits allowed by project time and budget.

- g. Again with reference to the assumption made at point d., partners assume that learners addressed by teachers and trainers who are the target group of this project possess and master corresponding competence levels. In other words, for example, partners assume that teachers and trainers addressed by this output are not called to provide their students with foundational literacies (e.g. national language literacy, numeracy, scientific literacy, ICT literacy, financial literacy and cultural/civic literacy). Differences are expected to occur among students at different EQF levels, however.
- h. As mentioned at point c., we focus more on soft and didactic skills than technical ones. By their nature, the former are expected to be crosscutting and sector-independent. Nevertheless, in response to partners' and partner territory's needs, when required we will focus more on the mechanic, mechatronic and automotive sectors, where advanced digital competences are necessary, the digital revolution is already started, and meaningful company experience is in place.
- i. The scope of this work is limited by partners' needs and by the project duration and budget. We do not have the presumption that this product is exhaustive.
- j. From point i. directly follows that, even if carried out by highly skilled specialists and expert researchers, this output is developed with a "bottom-up" approach, and is task-oriented rather than scientific-oriented.

3.2. Conducting the Survey

Survey method

The aim of this output is presenting the list and description of competences teachers and trainers should possess to adequately facilitate learners in the development of their 4.0 skills. To achieve that, the partners drew on three information sources:

- literature;
- own experience;
- external stakeholders.

They started by surveying existing studies and national policies about changes and challenges brought by 4.0 (see guidelines in Appendix 2). Partners conveyed their direct experience on this issue in their answers, too. Identifying categories of stakeholders to be interviewed in the subsequent phase was part of this task, too.

The information collected made it possible to prepare a draft for semi-structured interviews involving a number of stakeholders (also reported in Appendix 2).

Reaching out to stakeholders allowed then to collect their points of view and experiences. The original idea was to carry out one-to-one interviews and/or focus groups, either face-to-face or via web, targeting 5 to 10 stakeholders per territory (40 to 80 as a whole), preferably managers in companies (technical/production/operation/human resources), representatives of associations, social parts or Public Administrations involved in Education and Training, headmasters, directors, teachers or trainers either in VET schools or in Universities, etc..

This tasks aimed at investigating skills that companies expect by workers, and hence indirectly by teachers and trainers.

It is worthwhile remarking once again that partners' aim was not to carry out a scientific research, but to collect practical information and material suitable to develop subsequent

project output. Hence the relatively small number of interviewees and the bottom-up approach of interviews.

By comparing results in different territories, partners drafted the set of competences necessary to teachers and trainers to face challenges brought by 4.0, also defining the pattern to describe competences described at previous paragraph.

Figure 1 at page 6 shows the method adopted by partners.

Sample

The final sample consisted of 85 respondents from 11 European countries, that is partner countries (Austria, Belgium, Denmark, Finland, Italy, Portugal, Sweden and the United Kingdom), plus Cyprus, Croatia and Spain.

Figure 4 shows the sample composition.

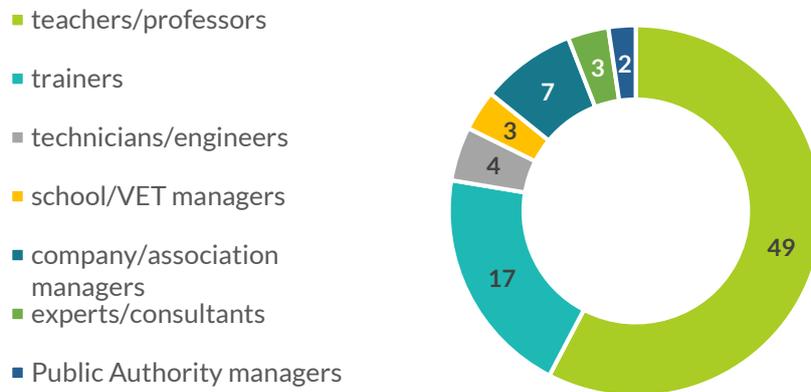


Figure 4 – Sample composition

47 respondents granted a face-to-face interview, while 38 were involved in focus groups (figure 5).



Figure 5 – Interview delivery method

The COVID-19 emergency

Partners initially scheduled interviews and focus groups in the period January-March 2020. The COVID-19 emergency forced the partners to review their plans, if not in substance, at least in terms and timing. Both partners and stakeholders involved in the survey, in fact, suddenly found themselves in the need to establish first of all internal emergency management strategies, such as reorganizing their work in smart/remote mode. To deal with this situation, the partners reshaped the conduct of the interviews and focus groups still to be carried out, transforming them from face-to-face to remote, and reschedule them. In this way, although the time frame was slightly extended, all activities were completed as planned.

3.3. Main findings

While carrying out the survey, partners realised the variety and richness of the information they were collecting. In fact, respondents not only provided for elements useful to define the set of competences forming the goal of this output, but also for comments, suggestions and a view of their perception of the impact of 4.0 on teaching and learning.

We try and summarize here some relevant findings, additional to the description of competences required to teachers. All material collected from the survey is available at partners', on request.

- There is a big talking about 4.0, not always brought down to the level of specific competences. Big companies provide directly specific competencies to their employees through their internal academies. Medium/large companies are quite aware of 4.0, and show a fair understanding of its meaning and implications. They look basically for people trained on 4.0 KET and “smart” in key competences. SME are still trying to understand what 4.0 is and what it implies. SME (plus many public bodies, also involved in the digital transformation) often do not show a good awareness of the phenomenon yet, and do not understand upcoming changes and how to cope with them.
- Learning objectives regarding new technologies, often are related to soft skills, too; local curricula have a bigger focus on soft skills than the national curricula, which are written by the NA of Education in collaboration with industry representatives.
- There is a strong need for experimental learning, to ensure seamless integration of theory and work life within the learning process.
- A real training environment, i.e. in companies, is key to that. So, a good challenge for teachers is finding a company with the “right” profile and the possibility to train for the defined learning outcomes.
- Access to examples of the technologies, cost and short shelf-life of tech items are a potential issue, however.
- EQF level 5 is probably the best performer in the 4.0 scenario: it deals with advanced, up-to-date topics, courses are often co-designed by training centers, schools and companies, work-based learning is applied, and so on. This makes the difference compared to EQF 4 and EQF 6.

- There is the risk of being pigeon-holed into one (big) company-specific technology, and only delivery the skill base / knowledge base relating to their technologies, in turn limiting the progression routes / scope of knowledge gained by the students.
- The biggest challenge for students will be not just passively listen and learn by absorbing contents from teachers and books but actively learn using critical thinking to deepen what their studying. They will have to accept the change (contents, learning processes and IT systems) thinking about it as an opportunity for their future and understanding their active role towards learning.
- The awareness of educators is fairly random, in that they know what they have read/seen/heard about, but there is a lack of direction from government and qualifications awarding bodies.
- Due to fast changing systems and approaches, a key challenge for teachers is innovating their teaching strategies and keeping themselves up-to date. They should understand the impact of technology on work organisation, understand what companies expect from students when they employ them, and be able to prepare students not only for technology, but also for a different work environment.
- Teaching based on independent and holistic project work, problem-based learning and case-studies, rather than lectures, will continue to dominate the way we train for Industry 4.0.. In other words, teachers should learn to design learning processes that take place in authentic learning environments. This implies having at one's disposal conceptual and practical tools that can support the process.
- Putting students at the center of the learning process, integrating IT systems in this scenario is crucial to succeed. That includes personalizing/customizing the training to the individual needs of learners.

4. Intellectual Output 1 – part 2: the competences

4.1. Methodology for output return

Notwithstanding the practical, bottom-up approach adopted by partners, some foundation is necessary, to provide this output with robustness and to correctly frame it within the existing EU standards and tools, to ensure usability and transferability. This paragraph describes choices made by partners to that aim.

Reference models

There are numerous frameworks available across Europe and globally describing competences, each created and driven by different reasons and designed to address different specific issues. For the purpose of our project, we considered five systems, each of them being somehow related to our goals:

The e-Competence Framework (e-CF)

The e-CF provides a reference of 41 competences as required and applied at the Information and Communication technology (ICT) professional work environment, using a common language for competences, skills and proficiency levels that can be understood across Europe. It is now a European standard (EN 16234-1:2019), established as a tool to support mutual understanding and provide transparency of language.¹⁹

The European Qualifications Framework (EQF)

The EQF is a common European reference framework for qualifications. Its purpose is to compare qualifications and learning outcomes, coming from different countries and national education systems. The EQF consists of 8 levels, ranging from the end of compulsory education (Levels 1 to 3) to the highest qualifications such as a Doctorate degree (Level 8). It covers all levels and all sub-systems of education and training, focussing on learning outcomes and the person's knowledge, skills and competences. Qualifications in the EQF are outcomes rather than input based. It is based on the recommendation adopted by the European Parliament and the Council on 23 April 2008.²⁰

The European credit system for vocational education and training (ECVET)

This is the technical framework for transfer, validation and, where appropriate, accumulation of learning outcomes by individuals, to achieve a qualification. ECVET tools and methodology comprise a description of qualifications in units of learning outcomes with associated points,

¹⁹ For general information about the e-CF, see <https://www.ecompetences.eu/>. Following consultation of CEN (Comité Européen de Normalisation) member states, the e-CF 3.0 became a European standard and was published in 2016 officially as the European Norm EN 16234. Its last version, EN16234-1:2019 “e-Competence Framework (e-CF)” can be purchased at the national sales points of the CEN member bodies.

²⁰ Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning (2008/C 111/01), available at: <https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2008:111:0001:0007:EN:PDF>. Reflecting the success in implementing the 2008 recommendation, a revised and strengthened Recommendation on the EQF was adopted on 22 May 2017 by the Education, Youth, Culture and Sport Council: <http://data.consilium.europa.eu/doc/document/ST-9620-2017-INIT/en/pdf>

a transfer and accumulation process and complementary documents such as learning agreements, transcripts of records and ECVET users' guides.

ECVET is based on the description of qualifications in terms of learning outcomes (knowledge, skills and/or competences), organised into transferable and accumulable learning units to which credit points are attached and registered in a personal transcript of learning outcomes.²¹

The European multilingual classification of Skills, Competences, Qualifications and Occupations (ESCO)

The ESCO classification identifies and categorises skills, competences, qualifications and occupations relevant for the EU labour market and education and training. It systematically shows the relationships between the different concepts. ESCO is designed to improve communication between the education and training sector and the European labour market. It encompasses (in its current version v1.0.7, as of 03/07/2020) 2942 occupations and 13485 skills in all fields. ESCO is structured on three pillars (occupations, skills/competences and knowledge and qualifications) representing a searchable database. The Directorate General for Employment, Social Affairs and Inclusion (DG EMPL) manages its development and continuous updating.²²

The Digital Competence Framework for citizens (DigComp)

DigComp is the main European framework for citizens' digital competence. Even if apparently near to the e-CF, DigComp addresses the European citizens as a whole as the users of digital/ICT services, while e-CF addresses the very specific group of ICT professionals. DigComp was developed by the Joint Research Center, initially on behalf of the Directorate General for Education, Audiovisuals and Culture (DG EAC) and, more recently, on behalf of the Directorate General for Employment, Social Affairs and Inclusion (DG EMPL). The current version is labelled DigComp 2.1.²³

The Entrepreneurship Competence Framework (EntreComp)

EntreComp offers a tool to improve the entrepreneurial capacity of European citizens and organisations. The framework aims to build consensus around a common understanding of entrepreneurship competence by defining 3 competence areas, a list of 15 competences, learning out-comes and proficiency levels, which current and future initiatives can refer to. EntreComp was developed by the Joint Research Centre (JRC) of the European Commission on behalf of the Directorate General for Employment, Social Affairs and Inclusion (DG EMPL).²⁴

From these sources partners took inspiration in designing the competences described at chapter 4, to ensure coherence with the main existing EU tools.

²¹ Recommendation of the European Parliament and of the Council of 18 June 2009 on the establishment of a European Credit System for Vocational Education and Training (ECVET) (Text with EEA relevance) (2009/C 155/02). Accessible at: [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009H0708\(02\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009H0708(02)&from=EN)

²² See <https://ec.europa.eu/esco/portal/home>

²³ The current version DigComp 2.1 can be downloaded at: [https://publications.jrc.ec.europa.eu/repository/bitstream/JRC106281/web-digcomp2.1.pdf_\(online\).pdf](https://publications.jrc.ec.europa.eu/repository/bitstream/JRC106281/web-digcomp2.1.pdf_(online).pdf)

²⁴ The document can be downloaded at: <https://publications.jrc.ec.europa.eu/repository/bitstream/JRC101581/lfna27939enn.pdf>

About competences

The word “competence” has different meanings, and remains one of the most diffuse terms in the management development sector, and the educational, organizational and occupational literature. Like “quality”, “competence” is a word commonly understood and its effects perceived by everybody, but hard to define in a unique way. Even the above-mentioned source documents provide for slight differences in the definition of competence. We recall here some of the most common wordings, making our choice for Fit for 4.0 goals.

The **Cedefop**²⁵ describes competence as the “*ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development)*”, or the “*ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development*”. Competence “*is not limited to cognitive elements (involving the use of theory, concepts or tacit knowledge); it also encompasses functional aspects (including technical skills) as well as interpersonal attributes (e.g. social or organisational skills) and ethical values*”.

The annex to the Council **Recommendation on key competences** for lifelong learning (2018/C 189/01)²⁶ defines competences as “*a combination of knowledge, skills and attitudes [KSA, Ed.], where:*

- *knowledge is composed of the facts and figures, concepts, ideas and theories which are already established and support the understanding of a certain area or subject;*
- *skills are defined as the ability and capacity to carry out processes and use the existing knowledge to achieve results;*
- *attitudes describe the disposition and mind-sets to act or react to ideas, persons or situations.”*

DigComp and EntreComp follow the same definition, both aiming at detailing one of the eight key competences encompassed by this recommendation.

Annex 1 to the Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the **EQF** for lifelong learning (2008/C 111/01)²⁷ states that “*‘competence’ means the proven ability to use knowledge, skills and personal, social and/or methodological abilities, in work or study situations and in professional and personal development.*” Each level in the EQF is defined by a set of descriptors indicating the relevant learning outcomes in terms of knowledge, skills, responsibility and autonomy. The ESCO follows the same definition.

The **e-CF** defines competence as the “*demonstrated ability to apply knowledge, skills and attitudes for achieving observable results*”.

²⁵ Cedefop (2014). Terminology of European education and training policy: a selection of 130 terms. 2nd ed. Luxembourg: Publications Office. Can be downloaded at: http://www.cedefop.europa.eu/EN/Files/4117_en.pdf

²⁶ The Recommendation can be downloaded at: [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604\(01\)&from=EN](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&from=EN)

²⁷ See note 17 above.

Competences and skills

The definition of skills and competencies is apparently similar. They both relate to the ability to do something well. However, there are inherent differences between these two terms. Skills are undoubtedly important when recruiting for a new position or assessing the capabilities of existing employees. However, in isolation, they are not enough to adequately assess whether an individual will be successful in a role, or whether they will have a healthy talent lifecycle (how employees move through a company once hired). That is where competencies come in. For example:

- **A skill is the ability to do something, while competences include behaviours.** One can learn computer programming just as to perform open heart surgery. These are skills. Competences specify how the individual carries out the skills they have. For example, 10 people might be skilled at computer programming, but perhaps only some of them will work in a way that is in line with company culture (e.g. being respectful of management, working efficiently, having good time management, being an effective team member, etc.).
- **Skills are specific, while competencies are broad.** A person can either perform open heart surgery and save someone's life, or they can't. But competences tell us what success looks like; they combine behaviour and knowledge with the required skills. For example, a talented open heart surgeon who is rude to their team or gives relatives bad news in a nonchalant manner, would not be considered to be succeeding in the role.

Hence, a competence is not a skill; on the contrary, a competence **embeds** skills. While competences are holistic concepts, skills are precise and definite abilities, either hard technical, e.g. make cost/benefit analysis, develop user interfaces; or soft, e.g. deploy empathy to learner needs, negotiate contract terms and conditions.

Describing competences

For the purposes of Fit for 4.0 we are more interested in the pragmatic approach, rather than the theoretical one. Well aware of the similarity and differences between the above-mentioned definitions, we will assume the e-CF definition, the descriptors indicated by the Recommendation on key competences and a structure and possible levels, linked to the two of them.

In this line, our "model" will describe competences through:

- a **domain**: teachers and trainers interact and work in an underpinning technological/digital context, with a **didactic** aim, experiencing lifelong learning and own **personal** development, with an overall view to **strategic** continuous improvement: we will therefore assign their competences to one of these three domains. Domains are level-independent (or cross-level), as they define fields of expertise, rather than measuring at what extent a competence is mastered. Boundaries of domains overlap and require adaptation in different contexts: in case a competence can refer to more of them, we will assign it to the best-fitting one;²⁸
- a **title**, uniquely identifying the competence;

²⁸ A specific remark is necessary about language skills. The ability of communicating, reading, understanding English language must be part of the teacher/trainer competences. Level B2 of the CEFR can be considered as a pre-requisite. At the same time, the use of English is implied in all domains at such a level, that the partnership decided not to introduce a separate domain, rather to explicit it in the components of competences at the knowledge, skills, attitude level.

- a **concise description**, providing for a general understanding of topics covered by the competence and tasks a teacher/trainer possessing that competence is expected to perform;
- **delivery levels**, that is, a more precise definition of how the competence applies to, or of the extent the competence should be mastered by teachers and trainers working respectively at EQF level 4, 5 or 6; this definition draws on the EQF, and is the same for all domains and competences;
- a (non-exhaustive) list of (suggested) components, as to **knowledge, skills and attitudes**. Non-exhaustivity accounts for the fact that competences themselves are dynamic, grow, change, adapt, new ones are acquired or built, useless ones are stored and kept, or left. More, topics covered by them have a lot to do with the digital transformation, and by their nature they evolve constantly.²⁹ Components might relate to more than a single competence, and can appear in several domains.

4.2. The competences

Synoptic view

The following table provides an overview of competences we identified.

Technological/digital underpinning context		
		<i>title</i>
<i>domain</i>	<i>Didactic</i>	D.1. – Design learning experiences with a 4.0 approach
		D.2. – Implement learning experiences with a 4.0 approach
		D.3. – Assess learning experiences with a 4.0 approach
		D.4. – Interact in learning environments 4.0-oriented
	<i>Personal</i>	P.1. – Keep oneself up-to-date
		P.2. – Information and knowledge management
	<i>Strategic</i>	S.1. – Process improvement
		S.2. – Innovating

²⁹ It is worthwhile remarking that some components we list at paragraph 2.4 could probably apply to any teacher or trainer, independently from the 4.0 perspective. Nevertheless, we consider those components especially relevant in a 4.0 context: making them explicit is a way to highlight their importance.

Didactic

Domain	Didactic						
Title	D.1. - Design learning experiences with a 4.0 approach						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • understands target group needs and gaps; • incorporates these onto learning plans as a tool for enabling learners' personal development and employability; • considers input previously received by all actors involved in the learning process (e.g. families, other students, other teachers or persons students interact with); • designs learning building on previous experiences; • involves labour market representatives in the design of learning modules, with special reference to the choice of learning outcomes; • interacts with colleagues, ensuring coherence between his/her training module/topic and the overall programme/scheme; • designs learning outcomes targeting also soft/cross skills required in a 4.0 environment; • preferably selects training methods and activities simulating the real work environment; • includes a careful planning of learning assessment in design; • plans delivery with a view to allowing learning anywhere anytime, hence foreseeing integration of digital tools in the teaching and learning experience, including in learning assessment; • whenever possible, links contents to the 4.0 environment. 						
Delivery levels	<p>The teacher/trainer should master this competence to such an extent to provide learners with:</p> <table border="1"> <tbody> <tr> <td>EQF 4</td> <td> <ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. </td> </tr> <tr> <td>EQF 5</td> <td> <ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. </td> </tr> <tr> <td>EQF 6</td> <td> <ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts; </td> </tr> </tbody> </table>	EQF 4	<ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. 	EQF 5	<ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. 	EQF 6	<ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts;
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		- the ability to take responsibility for managing professional development of individuals and groups.
Knowledge examples	K1. What is Industry 4.0 and its enabling technologies K2. Project management principles and most common methods K3. Quality management principles and most common approaches, including PDCA K4. and of the labour market in territories where learners are likely to work when completing their studies. K5. Main EU framework and tools (e.g. EQF, ECVET, EQAVET, etc.) K6. Recent approaches to learning in the framework of the digital transformation K7. Understanding of their respective strengths and weaknesses K8. Variety of learning methods and tools, both face-to-face and distance, including those for assessment K9. Understanding that learning is without boundaries: students can learn anywhere and anytime and have unlimited access to new information K10. General knowledge of learning outcomes and contents of other learning modules/units (if any) composing the learner's pathway K11. Understanding of the technical and financial requirements of a well-balanced learning programme	
Skills examples	S1. Strategic thinking S2. Planning skills S3. Ability to design by objectives S4. Ability to describe and report the full design process (needs analysis, choice of objectives and indicators, methods, activities, contents, resources, timing, assessment) S5. Ability to design new learning material, both starting from scratch and collecting and improving existing resources S6. Ability to find suitable real-life cases and transfer them into learning experiences S7. Ability to develop an array of strategies for sharing differences, identifying similarities, and embracing diversity within the learning environment S8. Ability to plan adopting active approaches (e.g. PBL, Project work, PoC, learning factory concept, real world experiences, etc.) S9. Ability to create student-centred learning processes S10. Teamworking S11. Creativity S12. Flexibility	
Attitudes examples	A1. Demonstrate understanding and appreciation of differences between value systems of different religious or ethnic groups. A2. Behave sustainably, demonstrating attention and care for the environment and to avoid resource consumption (reducing the usage of energy, water, paper and other materials)	

Domain	Didactic						
Title	D.2. - Implement learning experiences with a 4.0 approach						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • interprets his/her teaching as creating student-centred learning processes; • involves stakeholders in the delivery of learning; • interacts with colleagues, offering interdisciplinary learning opportunities; • collects input received by all actors involved in the learning process (e.g. families, other students, other teachers or persons students interact with); • applies training methods and activities favouring the development of soft/cross skills required in a 4.0 environment; • applies training methods and activities simulating the real work environment; • makes use of digital teaching and learning tools; • blends face-to-face and distance learning activities; • whenever possible, provides for feedback, examples, exercises and assignments making reference to the 4.0 environment; • enhances the 4.0 approach, highlighting its advantages through its words and actions; • adapts training plans to address changing demand. 						
Delivery levels	<p>The teacher/trainer should master this competence to such an extent to provide learners with:</p> <table border="1"> <tbody> <tr> <td>EQF 4</td> <td> <ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. </td> </tr> <tr> <td>EQF 5</td> <td> <ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. </td> </tr> <tr> <td>EQF 6</td> <td> <ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts; - the ability to take responsibility for managing professional development of individuals and groups. </td> </tr> </tbody> </table>	EQF 4	<ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. 	EQF 5	<ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. 	EQF 6	<ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts; - the ability to take responsibility for managing professional development of individuals and groups.
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Knowledge examples	K1. What is Industry 4.0 and its enabling technologies						

	<p>K2. Recent approaches to learning in the framework of the digital transformation</p> <p>K3. Understanding of their respective strengths and weaknesses</p> <p>K4. Available tools –digital and technological– supporting and enhancing the teaching and learning experience (e.g. videoconferencing, learning environments, collaboration tools, distance interaction tools, feedback collection, assessment tools, as well as educational devices, etc.)</p> <p>K5. Public speaking techniques</p> <p>K6. Work organisation and workplace environment in companies or bodies applying the 4.0 paradigm</p> <p>K7. Understanding of real life cases of 4.0 applications, drawn from the labour market</p> <p>K8. Safety concepts and regulations at the workplace in own country, with special reference to COVID-19 safety rules</p> <p>K9. General knowledge of learning outcomes and contents of other learning modules/units (if any) composing the learner’s pathway</p> <p>K10. Knowledge of a non-native language (preferably English) at least at level B2 of the CEFR.</p>
Skills examples	<p>S1. Ability to identify activities best fitting expected learning outcomes</p> <p>S2. Ability to deliver/coordinate (either personally and with external support/co-teaching) activities best fitting expected learning outcomes</p> <p>S3. Ability to implement active approaches (methods and activities) preparing to the real work environment (e.g. PBL, Project work, PoC, learning factory concept, real world experiences, etc.)</p> <p>S4. Ability to implement a holistic approach, considering and enhancing and making explicit links between own discipline/topic and the overall learning picture of the course/programme</p> <p>S5. Ability to target progression of individual learners</p> <p>S6. Ability to make use of digital learning tools (e.g. videoconferencing, learning environments, collaboration tools, distance interaction tools, feedback collection, assessment tools, etc.)</p> <p>S7. Ability to deliver learning opportunities both face-to-face and from the distance</p> <p>S8. Ability to mix and balance face-to-face and distance activities</p> <p>S9. Ability to deliver learning opportunities in a non-native language (preferably English) at least at level B2 of the CEFR</p> <p>S10. Ability to provide for feedback, examples, exercises and assignments making reference to the 4.0 environment</p> <p>S11. Ability to highlight advantages of the 4.0 approach</p>
Attitudes examples	<p>A1. Goal-orientation</p> <p>A2. Demonstrate ability to appreciate everybody’s contributions conveying them to the learning goals</p> <p>A3. Withhold judgement and encourage tolerance among learners</p> <p>A4. Demonstrate the ability to comply with safety regulations (in the learning environment and at the workplace)</p> <p>A5. Behave sustainably, demonstrating attention and care for the environment and to avoid resource consumption (reducing the usage of energy, water, paper and other materials)</p>



	A6. Empathy A7. Flexibility A8. Ability to motivate others
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Domain	Didactic						
Title	D.3. - Assess learning experiences with a 4.0 approach						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • observes learners, by listening and watching how they work, interact and behave; • monitors student learning; • collects and considers input received by all actors involved in the learning process (e.g. families, other students, other teachers or persons students interact with); • assesses learning regularly and frequently; • selects assessment methods and tools best fitting learners and contexts; • makes use of digital assessment tools; • applies assessment methods and tools best fitting learners and contexts, including self-assessment and peer assessment; • checks adequacy of chosen assessment methods to the purpose of accounting for actual learning; • adequately shares and discusses the results of assessments. 						
Delivery levels	<p>The teacher/trainer should master this competence to such an extent to provide learners with:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="width: 15%;">EQF 4</td> <td> <ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. </td> </tr> <tr> <td>EQF 5</td> <td> <ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. </td> </tr> <tr> <td>EQF 6</td> <td> <ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts; - the ability to take responsibility for managing professional development of individuals and groups. </td> </tr> </tbody> </table>	EQF 4	<ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. 	EQF 5	<ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. 	EQF 6	<ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts; - the ability to take responsibility for managing professional development of individuals and groups.
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Knowledge examples	<p>K1. What is Industry 4.0 and its enabling technologies</p> <p>K2. Knowledge of individual and collective expected learning outcomes</p> <p>K3. Quality management principles and most common approaches, including PDCA and EQAVET</p> <p>K4. Understanding of different assessment techniques and their scopes</p>						

	<p>K5. Tools for digital assessment and distance assessment and their scope (field of application, pros and cons)</p> <p>K6. General knowledge of learning outcomes and contents of other learning modules/units (if any) composing the learner's pathway</p>
Skills examples	<p>S1. Ability to monitor learning, by listening and watching how learners work, interact and behave</p> <p>S2. Ability to make students perceive assessment as a tool for improvement and part of the learning process, rather than a judgement or a sentence (downplaying the assessment, putting it into the right perspective, as a regular practice at the workplace)</p> <p>S3. Ability to make students perceive the difference between assessing their work and them as individuals</p> <p>S4. Ability to facilitate self-assessment and peer assessment</p> <p>S5. Ability to design and deliver assessments in coherence with learning outcomes</p> <p>S6. Ability to exploit digital tools for assessment</p> <p>S7. Ability to check the adequacy of chosen assessment methods to the purpose of accounting for actual learning</p> <p>S8. Ability to analyse assessment results from the pedagogic point of view</p> <p>S9. Ability to share and discuss assessment results with relevant recipients (individual learners, classroom, colleagues, etc.).</p>
Attitudes examples	<p>A1. Make assessment goals, process and methods explicit and shared from the very beginning ('setting the rules of the game')</p> <p>A2. Demonstrate that assessment is 'lived' as a continuous process (constant listening and watching)</p> <p>A3. Regularly and frequently offer assessment opportunities (assessment as a regular part of the game)</p> <p>A4. Look for learners' and stakeholders' feedback and assessment on own work</p> <p>A5. Involve stakeholders from the labour market in the assessment process, when possible</p> <p>A6. Always discuss assessment results with learners</p> <p>A7. Provide for feedback and feedforward, when discussing the results of assessment with learners</p>

Domain	Didactic						
Title	D.4. - Interact in learning environments 4.0-oriented						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • develops, maintains and nurtures positive relationships with students; • develops, maintains and nurtures positive relationships with colleagues; • develops, maintains and nurtures positive relationships with different stakeholders outside own organization; • facilitates the collaboration of multidisciplinary teams; • participates/guides learning activities involving students and companies; • demonstrates empathy with the different contexts and points of view of the various stakeholders; • chooses the communication methods and tools (with special reference to digital ones) most appropriate to the interlocutor and the context; • applies the communication methods and tools (with special reference to digital ones) most appropriate to the interlocutor and the context; • can adequately perform (plan, deliver, assess, relate, produce learning materials) in at least a second language (preferably English). 						
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Knowledge examples	<p>K1. What is Industry 4.0 and its enabling technologies</p> <p>K2. Organisation processes, including decision-making, budgets and management structure</p> <p>K3. Business objectives/needs of different stakeholders</p> <p>K4. Collaborative and agile methodologies</p>						

	<p>K5. Recent tools –especially the digital ones– supporting training delivery and learning (e.g. videoconferencing, learning environments, collaboration tools, distance interaction tools, feedback collection, assessment tools, etc.)</p> <p>K6. Public speaking techniques</p> <p>K7. Work organisation and workplace environment in companies or bodies applying the 4.0 paradigm</p> <p>K8. Knowledge of a non-native language (preferably English) at least at level B2 of the CEFR</p>
Skills examples	<p>S1. Playing an active role on one’s workplace</p> <p>S2. Manage communication in a multi-disciplinary team</p> <p>S3. Deploy empathy in a multi-stakeholder environment</p> <p>S4. Establish realistic expectations to support development of mutual trust</p> <p>S5. Ability to set and present common goals fulfilling different stakeholders’ objective/needs</p> <p>S6. Cognitive flexibility: ability to switch reference frames</p> <p>S7. Communicate good and bad news to avoid surprises</p> <p>S8. Apply mediation and conflict resolution techniques</p> <p>S9. Ability to facilitate and inspire learners</p> <p>S10. Ability to understand and set apart own biases, not to distort their relationships with learners and stakeholders</p> <p>S11. Co-create an overview of benefits brought by I4.0</p>
Attitudes examples	<p>A1. Demonstrate commitment</p> <p>A2. Demonstrate passion about building meaningful relationships</p> <p>A3. Look for learners’ and stakeholders’ feedback and assessment on own work</p>

Personal

Domain	Personal						
Title	P.1. - Keep oneself up-to-date						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • commits to continuous professional development; • organises and regulates one's own learning, both individually and in groups; • actively seeks learning opportunities, also in informal and non-formal mode; • investigates latest technology, digital, legal/ethical and teaching/learning developments, to establish understanding of evolution and to broaden own didactic 'toolkit'; • regularly self-assesses own preparation. 						
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Knowledge examples	<p>K1. General state of play of I4.0, its trends and developments, especially in relation with education and training</p> <p>K2. Sources of information and where they can be accessed</p> <p>K3. Knowledge and understanding of one's preferred learning methods, the strengths and weaknesses of one's skills and qualifications.</p> <p>K4. Knowledge of available education and training opportunities at a local, national, European and international level</p> <p>K5. Empowerment techniques</p> <p>K6. Understanding the impact of digitalisation on own work</p>						

<p>Skills examples</p>	<p>S1. Ability to understand the socio-economic and working context in which learners lives (local and European level)</p> <p>S2. Ability to identify own competence and skill gaps</p> <p>S3. Ability to analyse own potential (competences, motivation, expectations and perspectives)</p> <p>S4. Ability to set challenging personal goals</p> <p>S5. Ability to define and implement a plan to achieve goals set</p> <p>S6. Ability to incorporate within routine work processes, opportunities for skills development, validation and renewal</p> <p>S7. Ability to use support given by others to gather information and help meeting personal learning/development targets</p> <p>S8. Ability to search, find and maintain an overview of up-to-date standards, definitions and technologies within I4.0</p> <p>S9. Ability to understand and evaluate critically what is meant by targets, action points and deadlines, and the importance of reviewing targets and trying different ways of learning.</p> <p>S10. Ability to self-assess own preparation</p> <p>S11. Ability to “pick-up” ideas, tools, suggestions coming from learners</p>
<p>Attitudes examples</p>	<p>A1. Display self-esteem supporting a willingness to change and further develop competences</p> <p>A2. Display self-motivation and confidence in one’s ability to succeed</p> <p>A3. Display positive appreciation of learning as a life-enriching activity and a sense of initiative to learn</p> <p>A4. Display adaptability (to changes, new situations and contexts, etc.) and flexibility (in order to cope with them)</p> <p>A5. Display curiosity</p> <p>A6. Be proactive in piloting new learning methods/tools</p> <p>A7. Play one's role without stepping back or going beyond it</p>

Domain	Personal						
Title	P.2. - Information and knowledge management						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • identifies information and knowledge relevant to own work; • develops processes and structures to manage information; • processes and communicates information to others; • behaves ethically, informing own teaching/training behaviour through critical thinking, data assessment and interpretation, fact-checking and respect for privacy; • applies cybersecurity principles; • encourages learners to develop a critical mind-set; • promotes ethical behaviour among learners; • promotes safe cybersecurity behaviour among learners. 						
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Knowledge examples	<p>K1. Methods to analyse information and learning processes K2. Practical solutions for the storage and retrieval of information K3. Community management principles and tools K4. Ethical issues K5. Legal regulations (IPR, GDPR) K6. Cybersecurity principles K7. Collaboration principles and tools for communication and information sharing</p>						
Skills examples	<p>S1. Gather internal and external knowledge and information needs</p>						

	<p>S2. Formalise learning steps, from design to assessment and review, into structured information</p> <p>S3. Motivate and encourage people to share and communicate knowledge</p> <p>S4. Ability to search and find information</p> <p>S5. Check the reliability of a source or information, supporting it with verifiable data</p> <p>S6. Safely process new information and communicate it to others (including managing levels of access to information)</p> <p>S7. Apply critical thinking</p> <p>S8. Target critical thinking when delivering learning opportunities</p> <p>S9. Convey legal, ethical and safety/security issues in learning opportunities</p> <p>S10. Ability to share and promote “best practices” inside and outside one’s organisation, at all levels</p>
Attitudes examples	<p>A1. Provide learners with regular feedback and feedforward</p> <p>A2. Behave honestly and transparently</p> <p>A3. Share knowledge rather than defend knowledge</p> <p>A4. Perform in compliance with legal regulations, organisation values and professional ethics</p>

Strategic

Domain	Strategic	
Title	S.1. – Process improvement	
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • applies continuous improvement techniques (e.g. PDCA) to own work, possibly with a view to EU frameworks and tools; • designs, tests and suggests changes in processes or tools, supporting a continuous learning process in the organisation and in learners; • assesses and addresses risks involved in process change; • regularly reviews the adequacy of the learning process to achieve the expected learning outcomes, also involving all related stakeholders (students, colleagues, companies, etc.); • makes use of findings of regular reviews to adjust and enhance learning experiences; • reports and shares finding of regular reviews. 	
Delivery levels	The teacher/trainer should master this competence to such an extent to provide learners with:	
	EQF 4	<ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities.
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Knowledge examples	<p>K1. Quality management principles and most common approaches, including PDCA and EQAVET</p> <p>K2. Process management methodologies (e.g. classic, Agile, XPM, Scrum, lean, Kanban, etc.) and their relationships to I4.0 (e.g. big data, IoT, etc.)</p> <p>K3. Existing internal processes</p> <p>K4. Available resources</p>	
Skills examples	S1. Apply process management techniques	

	<p>S2. Ability to observe and listen, reading the context as to catch improvement opportunities</p> <p>S3. Curiosity</p> <p>S4. Propose process changes to facilitate improvement</p> <p>S5. Review processes, learning environment and tools</p> <p>S6. Identify appropriate resources, applying sustainability criteria</p> <p>S7. Address risks involved in process change</p> <p>S8. Implement changes, also by exploiting findings of process review</p>
Attitudes examples	<p>A1. Demonstrate openness to change</p> <p>A2. Support learners in identifying and resolving problems</p> <p>A3. Support colleagues in identifying and resolving problems</p>

Domain	Strategic						
Title	S.2. – Innovating						
Concise description	<p>The teacher/trainer:</p> <ul style="list-style-type: none"> • encourages and explores internal and external sources for innovative ideas and opportunities in relation to new trends; • devises creative solutions for the adoption or integration of existing or new technology/ideas into existing activities/processes or for the creation of new ones; • applies environmental and sustainability criteria to his/her performance; • tests new approaches, methods and tools; • encourages open thinking among learners; • makes use of pro-active techniques rather than reactive. 						
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EQF 4	<ul style="list-style-type: none"> - factual and theoretical knowledge of a topic in broad contexts; - a range of cognitive and practical skills required to generate solutions to specific problems; - the ability to exercise self-management within the guidelines of contexts that are usually predictable, but are subject to change; - the ability to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities. 						
EQF 5	<ul style="list-style-type: none"> - comprehensive, specialised, factual and theoretical knowledge of the topic, plus awareness of the boundaries of that knowledge; - a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; - the ability to exercise management and supervision in contexts of work or study activities where there is unpredictable change review and develop performance of self and others. 						
EQF 6	<ul style="list-style-type: none"> - advanced knowledge of a topic, involving a critical understanding of theories and principles; - advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in the relevant specialised field; - the ability to manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable contexts; - the ability to take responsibility for managing professional development of individuals and groups. 						
Knowledge examples	<p>K1. Existing and emerging trends in society, education and training, labour world, technology and market applications</p> <p>K2. Own organisation habits, trends and needs</p> <p>K3. Innovation processes techniques</p> <p>K4. Innovation management methods and standards (e.g. Design Thinking, Co-creation, User-Centric Innovation)</p> <p>K5. Principles of risk management</p>						
Skills examples	<p>S1. Monitor innovation trends</p> <p>S2. Interpret external data and trends and analyse information</p> <p>S3. Apply what-if techniques to produce realistic outlooks</p>						

	<p>S4. Apply risk management techniques S5. Identify learning/organisation advantages and improvements of adopting emerging approaches/technologies S6. Convey innovation into learning opportunities S7. Create a Proof of Concept S8. Develop original ideas which are not limited by current constraints/rules S9. Identify appropriate resources, applying sustainability criteria S10. Test new approaches, methods and tools S11. Target critical thinking when delivering learning opportunities S12. Manage proactive techniques rather than reactive</p>
Attitudes examples	<p>A1. Demonstrate appreciation for new ideas A2. Demonstrate openness to change A3. Test new approaches and hypotheses A4. Consider learners as resources for innovation, encouraging the production of feedback and new ideas and valuing their contributions to change</p>

5. Next steps

Based on project requirements, within the boundaries of assumptions made at paragraph 3.1. and following the process described in previous chapters, partners identified a set of eight broad competences they consider necessary for a teacher/trainer to perform in a 4.0 environment. Partners also devised a pattern to describe those competences and proposed a variety of examples characterizing them in terms of knowledge, skills and attitudes.

This rich material will guide partners in the development of the next project outputs. In detail:

- to develop a self-assessment test for teachers and trainers. This output is meant to let VET teachers check their own competence level about the 4.0 “world”, i.e. to measure somehow their readiness to co-operate in a 4.0 training and learning environment. It will consist in an on-line tool for self-assessment, which will return feedback as to:
 - background knowledge;
 - knowledge of technology aspects;
 - understanding of implications on organization/impact on work environment;
 - knowledge/mastership of tools for designing, managing, assessing learning in a 4.0 perspective;
 - inclination to change;
 - ability to interact in a multi-actor environment.

Users will get not just a numeric assessment, rather suggestions for improvement.

Based on the present output, the tool will be available in all partner languages on the project web platform for free. Partners will exploit it to assess the readiness of a sample group of teachers up- and downstream the train-the-trainer course to be developed as part of Fit for 4.0 as well, that is, to measure trainers’ learning outcomes.

- to design the learning objectives and to set assessment goals of a train-the-trainers programme, meant as an empowering tool to bridge the gap that might come up from the self-assessment at previous point.
- to disseminate findings to other teachers and trainers, education and training stakeholders, companies and policy-makers in general.

Appendix 1 – Glossary

Adult education

All forms of non-vocational adult education, whether of a formal, non-formal or informal nature.

Source: *European Commission (2019): Erasmus+ Programme Guide, version 2 (2019).*

Apprenticeship

Systematic, long-term training alternating periods at the workplace and in an educational institution or training centre. The apprentice is contractually linked to the employer and receives remuneration (wage or allowance). The employer assumes responsibility for providing the trainee with training leading to a specific occupation.

In French, the term ‘apprentissage’ relates to both apprenticeship and the process of learning (see ‘learning’);

The German ‘dual system’ is an example of apprenticeship.

Apprenticeship-type schemes are understood as those forms of Initial Vocational Education and Training (IVET) that formally combine and alternate company based training (periods of practical work experience at a workplace) with school based education (periods of theoretical/practical education followed in a school or training center), and whose successful completion leads to nationally recognised initial VET qualifications

Sources:

- *Cedefop; Tissot, P. (2004). Terminology of vocational training policy – A multilingual glossary for an enlarged Europe. Luxembourg: Publications Office.*
- *European Commission (2019): Erasmus+ Programme Guide, version 2 (2019).*

Assessment of learning outcomes

The process of appraising knowledge, know-how, skills and/or competences of an individual against predefined criteria (learning expectations, measurement of learning outcomes). Assessment is typically followed by validation and certification.

In the literature, ‘assessment’ generally refers to appraisal of individuals whereas ‘evaluation’ is more frequently used to describe appraisal of education and training methods or providers.

Source: *Cedefop, 2004.*

Basic skills

The skills needed to live in contemporary society, e.g. listening, speaking, reading, writing and mathematics. Combined with new basic skills, basic skills form key skills.

Source: *Cedefop, Bjørnåvold, 2000; Cedefop, Tissot, 2000; Cedefop, 2004.*

Certificate / diploma / title

An official document, issued by an awarding body, which records the achievements of an individual following an assessment and validation against a predefined standard.

Source: *based on Cedefop, 2004.*

Certification of learning outcomes

Process of issuing a certificate, diploma or title formally attesting that a set of learning outcomes (knowledge, know-how, skills and/or competences) acquired by an individual have been assessed by a competent body against a predefined standard.

Source: Cedefop (2008). *Terminology of European education and training policy – A selection of 100 key terms*. Luxembourg: Publications office. http://www.cedefop.europa.eu/en/files/4064_en.pdf [accessed 30.7.2020].

Common European Framework of Reference for Languages (CEFR)

The Common European Framework provides a common basis for the elaboration of language syllabuses, curriculum guidelines, examinations, textbooks, etc. across Europe. It describes in a comprehensive way what language learners have to learn to do in order to use a language for communication and what knowledge and skills they have to develop to be able to act effectively. The Framework also defines levels of proficiency which allow learners' progress to be measured at each stage of learning and on a life-long basis. The CEFR divides learners into three broad divisions that can be divided into six levels (from A1, lowest, to C2, highest); for each level, it describes what a learner is supposed to be able to do in reading, listening, speaking and writing.

Source: Council of Europe (2001). *Common European Framework of Reference for Languages: Learning, teaching, assessing*. Cambridge Press. <https://rm.coe.int/1680459f97> [accessed 30.7.2020]

Competence

The ability to apply learning outcomes adequately in a defined context (education, work, personal or professional development). Competence is not limited to cognitive elements (involving the use of theory, concepts or tacit knowledge); it also encompasses functional aspects (involving technical skills) as well as interpersonal attributes (e.g. social or organisational skills) and ethical values. Source: Cedefop, 2004, European Commission, 2006a.

Continuing education and training

Education or training after initial education and training – or after entry into working life aimed at helping individuals to:

- improve or update their knowledge and/or skills;
- acquire new skills for a career move or retraining;
- continue their personal or professional development.

Continuing education and training is part of lifelong learning and may encompass any kind of education (general, specialised or vocational, formal or non-formal, etc.). It is crucial for the employability of individuals.

Source: Cedefop, 2004.

Curriculum

Inventory of activities related to the design, organisation and planning of an education or training action, including definition of learning objectives, content, methods (including assessment) and material, as well as arrangements for training teachers and trainers. The term 'curriculum' refers to the design, organisation and planning of learning activities while the term 'programme' refers to the implementation of these activities.

Source: Cedefop (2008). *Terminology of European education and training policy – A selection of 100 key terms*. Luxembourg: Publications office. http://www.cedefop.europa.eu/en/files/4064_en.pdf [accessed 30.7.2020]. Landsheere, 1979.

Education or training pathway

A set of related education or training programmes provided by schools, training centres, higher education institutions or VET providers, and that facilitates individuals' progression within or between activity sectors.

Source: Cedefop; European Commission, 2006c.

Education or training provider

Any organisation or individual providing education or training services. Education and training providers may be organisations specifically set up for this purpose, or they may be other, such as employers, who provide training as a part of their business activities. Training providers also include independent individuals who offer services.

Source: based on Cedefop, 2004.

Erasmus+

The European Commission's Programme for education, training, youth and sport for the period 2014–2020, succeeding the previous Lifelong Learning Programme (2007–2014). As an integrated programme, Erasmus+ offers more opportunities for mobility of learners and staff and cooperation across the education, training and youth sectors and is easier to access than its predecessors, with simplified funding rules and a structure which aims to streamline the administration of the programme.

Source: European Commission.

Europass

Portfolio of five documents helping citizens to better communicate their skills and qualifications when applying for job or study in Europe. The Europass CV and the language Passport are completed by citizens themselves; the other three documents can be issued to citizens who achieve a mobility experience in another European country (Europass mobility) or who complete a formal programme of Vocational Education or Training (certificate supplement) or of Higher Education (diploma supplement). Europass promotes an adequate appreciation of learning outcomes acquired in formal, non-formal or informal settings.

Source: Cedefop.

European credit system for vocational education and training (ECVET)

Technical framework for transfer, validation and, where appropriate, accumulation of learning outcomes by individuals, to achieve a qualification. ECVET tools and methodology comprise a description of qualifications in units of learning outcomes with associated points, a transfer and accumulation process and complementary documents such as learning agreements, transcripts of records and ECVET users' guides.

The ECVET framework aims to promote:

- mobility of people undertaking training;
- accumulation, transfer and validation of learning outcomes (either formal, non-formal or informal) acquired in different countries;
- implementation of lifelong learning;

- transparency of qualifications;
- common trust and cooperation between providers of vocational training and education in Europe.

ECVET is based on the description of qualifications in terms of learning outcomes (knowledge, skills and/or competences), organised into transferable and accumulable learning units to which credit points are attached and registered in a personal transcript of learning outcomes.

Source: Cedefop; European Parliament and Council of the European Union, 2009a

European credit transfer and accumulation system (ECTS)

A systematic way of describing a higher education programme by attaching credits to its components (modules, courses, placements, dissertation work, etc.), to:

- make study programmes easy to read and compare for all students, local and foreign;
- encourage mobility of students and recognition of formal, non-formal and informal learning;
- help universities to organise and revise their study programmes.

ECTS is based on the student workload required to achieve the objectives of a programme, specified in terms of learning outcomes to be acquired. The student workload of a fulltime study programme in Europe amounts in most cases to around 1500-1800 hours per year and in those cases one credit stands for around 25 to 30 working hours. Individuals who can demonstrate similar learning outcomes acquired in other learning settings may obtain recognition and credits (waivers) from the degree awarding bodies.

Source: Cedefop, 2008, based on European Commission, 2004.

European qualification framework for lifelong learning (EQF)

A reference tool for the description and comparison of qualification levels in qualifications systems developed at national, international or sectoral level. The EQF's main components are a set of 8 reference levels described in terms of learning outcomes (a combination of knowledge, skills and/or competences) and mechanisms and principles for voluntary cooperation. The eight levels cover the entire span of qualifications from those recognising basic knowledge, skills and competences to those awarded at the highest level of academic and professional and vocational education and training. EQF is a translation device for qualification systems.

Source: based on European Parliament and Council of the European Union, 2008.

European quality assurance in vocational education and training (EQAVET)

Reference framework to help EU member States and participating countries develop, improve, guide and assess the quality of their own vocational education and training systems. The methodology proposed by the framework is based on:

- a cycle consisting of four phases (planning, implementation, assessment and review) described for VET providers/systems;
- quality criteria and indicative descriptors for each phase of the cycle;
- common indicators for assessing targets, methods, procedures and training results.

Some indicators are based on statistical data, others are of a qualitative nature.

Source: Cedefop, based on European Parliament and Council of the European Union, 2009(b)

Extreme Project Management (XPM)

Extreme project management (XPM) refers to a method of managing very complex and very uncertain projects. It differs from traditional project management mainly in its open, elastic and undeterministic approach. The main focus of XPM is on the human side of project management (e.g. managing project stakeholders), rather than on intricate scheduling techniques and heavy formalism.

Source: Wikipedia.

Flipped classroom

A flipped classroom is a type of blended learning where students are introduced to content at home and practice working through it at school. This is the reverse of the more common practice of introducing new content at school, then assigning homework and projects to completed by the students independently at home.

In this blended learning approach, face-to-face interaction is mixed with independent study—usually via technology. In a common Flipped Classroom scenario, students might watch pre-recorded videos at home, then come to school to do the homework armed with questions and at least some background knowledge. The basic idea behind the Flipped Classroom is that the lesson becomes homework while the time in class is used for collaborative activities, experiences, debates, and workshops. In this scenario, the teacher does not play the role of a lead actor but becomes a kind of facilitator, the director of the educational activities. In the time at home, extensive use is made of video and other digital resources as contents to be studied, while in class students experiment, collaborate, and carry out workshop activities.

Source: INDIRE (2019). Flipped Classroom.

General Data Protection Regulation (GDPR)

The GDPR lays down rules relating to the protection of natural persons with regard to the processing of personal data and rules relating to the free movement of personal data in the EU. It protects fundamental rights and freedoms of natural persons and in particular their right to the protection of personal data. The Regulation applies to the processing of personal data wholly or partly by automated means and to the processing other than by automated means of personal data which form part of a filing system or are intended to form part of a filing system.

Source: Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016, available at: <https://eur-lex.europa.eu/eli/reg/2016/679/oj>

Guidance and Counselling

Range of activities designed to help individuals to take educational, vocational or personal decisions and to carry them out before and after they enter the labour market.

Guidance and counselling may include:

- counselling (personal or career development, educational guidance);
- assessment (psychological or competence/performance related);
- information on learning and labour market opportunities and career management;
- consultation with peers, relatives or educators;
- vocational preparation (pinpointing skills/competences and experience for job-seeking);
- referrals (to learning and career specialists);

Guidance and counselling can be provided at schools, training centres, job centres, the workplace, the community or in other settings.

Source: Cedefop (2008). *Terminology of European education and training policy – A selection of 100 key terms*. Luxembourg: Publications office. http://www.cedefop.europa.eu/en/files/4064_en.pdf [accessed 30.7.2020].

Higher Education Institution

Any type of higher education institution which, in accordance with national law or practice, offers recognised degrees or other recognised tertiary level qualifications, whatever such establishment may be called, or any institution which, in accordance with national law or practice, offers vocational education or training at tertiary level.

Source: European Commission (2019): *Erasmus+ Programme Guide, version 2 (2019)*.

In-company training / On-the-job training

Vocational training given in the normal work situation. It may constitute the whole training or be combined with off-the-job training.

Source: Unesco; Titmus, C. et al. (1979). *Terminology of adult education [Terminologia de la educación de adultos/Terminologie de l'éducation des adultes]*. Paris: Unesco.

Initial Vocational Education and Training (IVET)

Vocational education and training carried out in the initial education system, usually before entering working life.

Source: Cedefop, 2008.

Internet of Things (IoT)

The Internet of things (IoT) is a system of interrelated computing devices, mechanical and digital machines provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

Even if the main concept of a network of smart devices was discussed as early as 1982, the term "Internet of things" was likely coined by Kevin Ashton of Procter & Gamble in 1999.

Source: Wikipedia.

Key skills / key competences

The sum of skills (basic and new basic skills) needed to live in contemporary knowledge society. In its Recommendation on key competences for lifelong learning, the European Commission sets out the eight key competences: communication in the mother tongue; communication in foreign languages; competences in maths, science and technology; digital competence; learning to learn; interpersonal, intercultural and social competences, and civic competence; entrepreneurship; cultural expression.

Source: Cedefop, 2004; European Commission, 2006b. *Related terms: basic skills, new basic skills*

Knowledge

The outcome of the assimilation of information through learning. Knowledge is the body of facts, principles, theories and practices that is related to a field of study or work. There are numerous definitions of knowledge. Nevertheless, modern conceptions of knowledge rest broadly on several basic distinctions: (a) Aristotle distinguished between theoretical and practical logic. In line with this distinction, modern theoreticians (Alexander et al., 1991) distinguish declarative (theoretical) knowledge from procedural (practical) knowledge. Declarative knowledge includes assertions on specific events, facts and empirical

generalisations, as well as deeper principles on the nature of reality. Procedural knowledge includes heuristics, methods, plans, practices, procedures, routines, strategies, tactics, techniques and tricks (Ohlsson, 1994); (b) it is possible to differentiate between forms of knowledge which represent different ways of learning about the world. Various attempts have been made to compile such lists, the following categories seem to be frequently represented: – objective (natural/scientific) knowledge, judged on the basis of certainty; – subjective (literary/aesthetic) knowledge judged on the basis of authenticity; – moral (human/normative) knowledge judged on the basis of collective acceptance (right/wrong); – religious/divine knowledge judged by reference to a divine authority (God). This basic understanding of knowledge underpins the questions we ask, the methods we use and the answers we give in our search for knowledge; (c) knowledge encompasses tacit and explicit knowledge. Tacit knowledge (Polanyi, 1967) is knowledge learners possess which influences cognitive processing. However, they may not necessarily express it or be aware of it. Explicit knowledge is knowledge a learner is conscious of, including tacit knowledge that converts into an explicit form by becoming an ‘object of thought’ (Prawat, 1989). *Source: Cedefop, 2004; European Commission, 2006a.*

Learning

A process by which an individual assimilates information, ideas and values and thus acquires knowledge, know-how, skills and/or competences. Learning occurs through personal reflection, reconstruction and social interaction. Learning may take place in formal, non-formal or informal settings.

Source: Cedefop, 2004; European Commission, 2006a. Related terms: formal learning, informal learning, learning by doing, learning by using, non-formal learning

Learning outcomes / learning attainments

Set of knowledge, skills and/or competences an individual has acquired and/or is able to demonstrate after completion of a learning process, either formal, non-formal or informal. Statements of what a learner knows, understands and is able to do on completion of a learning process, which are defined in terms of knowledge, skills and competence.

Sources:

- *Cedefop (2008). Terminology of European education and training policy – A selection of 100 key terms. Luxembourg: Publications office.*
http://www.cedefop.europa.eu/en/files/4064_en.pdf [accessed 30.7.2020].
- *European Parliament and Council of the European Union (2008). Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European qualifications framework for lifelong learning. official Journal of the European Union, C 111, 6.5.2008, pp. 1-7.*

<http://eur-lex.europa.eu/lexuriServ/lexuriServ.do?uri=oJ:c:2008:111:0001:0007:en:Pdf> [accessed 30.7.2020].

Lifelong learning

All learning activity undertaken throughout life, which results in improving knowledge, know-how, skills, competences and/or qualifications for personal, social and/or professional reasons.

Source: based on Cedefop, 2004.

On-the-job training

Vocational training given in the normal work situation. It may constitute the whole training or be combined with off-the-job training.

Source: based on Unesco, 1979.

Open Educational Resources (OER)

Open educational resources (OER) are freely accessible, openly licensed text, media, and other digital assets that are useful for teaching, learning, and assessing as well as for research purposes. The term OER describes publicly accessible materials and resources for any user to use, re-mix, improve and redistribute under some licenses. The term "open educational resources" was first adopted at UNESCO's 2002 Forum on the Impact of Open Courseware for Higher Education in Developing Countries.

Source: Wikipedia.

Plan-Do-Check-Act (PDCA)

PDCA (plan-do-check-act or plan-do-check-adjust) is an iterative four-step management method used in business for the control and continuous improvement of processes and products. It is also known as the Deming circle/cycle/wheel.

Source: Wikipedia.

Project-based learning (PBL)

Project-based learning (PBL) is a comprehensive approach to classroom teaching and learning that is designed to engage students in investigation of authentic problems. Within this framework, students pursue solutions to nontrivial problems by asking and refining questions, debating ideas, making predictions, designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating their ideas and finding to others, asking new questions and creating artifacts.

Source: Blumenfeld et al., 1991. Motivating Project-Based Learning: sustaining the doing, supporting the learning.

Proof of Concept (PoC)

Proof of concept or proof of principle is a realization of a certain method or idea in order to demonstrate its feasibility, or a demonstration in principle with the aim of verifying that some concept or theory has practical potential. A proof of concept is usually small and may or may not be complete.

Source: Wikipedia..

Qualification

Qualification covers different aspects:

- Formal qualification: the formal outcome (certificate, diploma or title) of an assessment process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards and/or possesses the necessary competence to do a job in a specific area of work. A qualification confers official recognition of the value of learning outcomes in the labour market and in education and training. a qualification can be a legal entitlement to practice a trade (OECD);
- Job requirements: knowledge, aptitudes and skills required to perform specific tasks attached to a particular work position (ILO).

Sources:

- Cedefop (2008). *Terminology of European education and training policy – A selection of 100 key terms*. Luxembourg: Publications Office.
http://www.cedefop.europa.eu/en/files/4064_en.pdf [accessed 30.7.2020].
- Eurydice (2006). *TESE – Thesaurus for education systems in Europe*. Brussels: Eurydice.
<http://www.eurydice.org/portal/page/portal/eurydice/showPresentation?pubid=051en> [accessed 30.7.2020].
- ETF –european training foundation (1997). *Glossary of labour market terms and standard and curriculum development terms*. Turin: ETF.
- OECD (2007). *Qualifications systems: bridges to lifelong learning [Systèmes de certification: des passerelles pour apprendre à tout âge]*. Paris: OECD.
- ILO – International Labour Organization (1998). *ILO thesaurus [Thesaurus BIT = Tesauro OIT]: labour, employment and training terminology*. Geneva: ILO.
<http://www.ilo.org/public/english/support/lib/tools/aboutthes.htm> [accessed 30.7.2020].

Recognition of learning outcomes

- a. Formal recognition: the process of granting official status to skills and competences either through the:
 - award of qualifications (certificates, diploma or titles); or
 - grant of equivalence, credit units or waivers, validation of gained skills and/or competences;
- b. Social recognition: the acknowledgement of the value of skills and/or competences by economic and social stakeholders.

Source: Cedefop, 2004.

Skill

The ability to perform tasks and solve problems.

Source: Cedefop; European Commission, 2006a.

Staff

Persons who, on either a professional or a voluntary basis, are involved in education, training or youth non-formal learning, and may include professors, teachers, trainers, school leaders, youth workers and non-educational staff.

Source: Regulation (EU) No 1288/2013 of the European Parliament and of the Council of 11 December 2013 establishing 'Erasmus+': the Union programme for education, training, youth and sport and repealing Decisions No 1719/2006/EC, No 1720/2006/EC and No 1298/2008/EC (1), Official Journal of the European Union L347, 20 December 2013

Stakeholder

A person with an interest or concern in something, especially a business. In mobility, all parties somehow involved in mobility processes.

Source: Oxford Dictionary.

Teacher

Person whose function is to impart knowledge, know-how or skills to learners in an education or training institution. A teacher may fulfil several tasks such as organizing and carrying out training programmes/courses and transmitting knowledge, whether generic or specific, theoretical or practical. A teacher in a vocationally-oriented institution may be referred to as a 'trainer'.

Sources:

- Cedefop; Tissot, P. (2004). *Terminology of vocational training policy – A multilingual glossary for an enlarged Europe*. Luxembourg: Publications Office.
- AFPA – *Association nationale pour la formation professionnelle des adultes* (1992). *Vocabulaire des formateurs [Vocabulary of trainers]*. Paris: AFPA.

Traineeship (work placement)

Spending a period of time in an enterprise or organisation in another country, with a view to acquire specific competences that are required by the labour market, carry out work experience and improve the understanding of the economic and social culture of that country.

Source: European Commission (2019): *Erasmus+ Programme Guide, version 2 (2019)*.

Trainer

Anyone who fulfils one or more activities linked to the (theoretical or practical) training function, either in an institution for education or training, or at the workplace.

Two categories of trainer can be distinguished:

- professional trainers are training specialists whose job may coincide with that of the teacher in a vocational training establishment;
- part-time or occasional trainers are professionals in various fields who take on, in their normal duties, part-time training activity, either in-company (as mentors and tutors of recruits and apprentices or as training providers) or externally (by occasionally offering their services at a training establishment).

Trainers may carry out various tasks:

- design training activities;
- organise and implement these activities;
- provide the actual training (transfer knowledge, know-how and skills);
- help apprentices develop their skills by providing advice, instructions and comments throughout the apprenticeship.

Sources:

- Cedefop; Tissot, P. (2004). *Terminology of vocational training policy – A multilingual glossary for an enlarged Europe*. Luxembourg: Publications Office.
- AFPA – *Association nationale pour la formation professionnelle des adultes* (1992). *Vocabulaire des formateurs [Vocabulary of trainers]*. Paris: AFPA.

Validation of learning outcomes

Confirmation by a competent body that learning outcomes (knowledge, skills and/or competences) acquired by an individual in a formal, non-formal or informal setting have been assessed against predefined criteria and are compliant with the requirements of a validation standard. Validation typically leads to certification.

Source: Cedefop.

Vocational education and training (VET)

Education and training which aims to equip people with knowledge, know-how, skills and/or competences required in particular occupations or more broadly on the labour market.

Source: *ETF – European training foundation (1997). Glossary of labour market terms and standard and curriculum development terms.* Turin: ETF.

Work-based learning

Acquisition of knowledge and skills through carrying out – and reflecting on – tasks in a vocational context, either at the workplace (such as alternance training) or in a VET institution.

Source: *Cedefop (2011). Glossary – Quality in education and training/Glossar – Qualität in der allgemeinen und beruflichen Bildung/Glossaire – La qualité dans l'enseignement et la formation.* Luxembourg: Publications Office. http://www.cedefop.europa.eu/en/files/4106_en.pdf [accessed 30.7.2020].

Workplace learning

Study type which involves the acquisition of knowledge, skills and competences through carrying out – and reflecting on – tasks in a vocational context, either at the workplace (such as alternance training) or in a vocational education and training institution.

Source: *European Commission (2019): Erasmus+ Programme Guide, version 2 (2019).*

Young people

Individuals aged between 13 and 30.

Source: *Regulation (EU) No 1288/2013 of the European Parliament and of the Council of 11 December 2013 establishing 'Erasmus+': the Union programme for education, training, youth and sport and repealing Decisions No 1719/2006/EC, No 1720/2006/EC and No 1298/2008/EC (1), Official Journal of the European Union L347, 20 December 2013*

Appendix 2 – Survey templates

Guidelines for desk survey

What **learning objectives** are mentioned in the curriculum for education and national strategies regarding Industry 4.0?

Technical competencies	Soft competencies
<ul style="list-style-type: none"> • • • ... 	<ul style="list-style-type: none"> • • • ...

Do you have examples from companies or politicians who demand **specific competencies** when working in Industry 4.0?

From what you know now, where do you see a **lack of competences** between the Industry and the education, in relation to industry 4.0?

Based on your research and experience, evaluate which known **didactic approach** will you prefer and why, when teaching in Industry 4.0: (e.g. Project work, Problem-based learning, Prototyping, Cross-disciplinary, Instruction, Flipped classroom, VET, Lecture etc.)

1.	Case-studies/problem-based learning including cross-disciplinary approach – because it fosters independent problem solving and brings a holistic perspective to the task – very much like in professional life; Problem or challenge related to real cases; Real problem-based learning activities that the students know from the companies and where the solutions can be used.
2.	Project work (Future Factory as a multi-professional learning platform); it fosters soft skills such as collaboration, communication and independent problem solving; Project work, because it brings learners to approach topics from a broader and more industry-related perspective; Project work as learners can choose their own project to develop competencies and develops organizational skills as well; learning to see the whole picture of a project that is being implemented in business
3.	Explorative and cooperative Learning in flipped classroom settings as it fosters the community spirit, engages learners and their curiosity, builds up self-reliability and self-efficacy ; Flipped classroom (eLearning)+
4.	Cross-disciplinary approach would be necessary, to mirror the “reality” students will find at the workplace; Multiform learning; Cross disciplinary approaches are important in Industry 4.0 as it gives a range of perspectives on problems and challenges
5.	VET and/or real environment – we train our students for professional life and this is best achieved at the work place. But sometimes you need a training environment <i>similar to</i> the work place, like a testbed or the demonstrator GTC has constructed for the project Smart Factory; Qualified testimonial could also work, because they could bring into the “classroom” the feeling and needs of a real work environment; Laboratory practice hours; Internship

6	Design thinking: Working systematically on idea generating and how data can be used in specific projects. Prototyping as it helps learners getting in hands on mindset and helps them getting ideas into actions really fast
7.	Collaborative tools/methods, more generally speaking, in order to prepare learners as much as possible to act the same way they will when in a company (those could include also design thinking, hackathons, etc.); Team working
8.	Permanent evaluation through the whole track: testing of competences, theory, skills, evaluation of project work; Portfolio and reflection
9.	Instruction, Lecture; Visiting lecturers from world of work: Industry 4.0 specialists
10.	Practical classes English in order to be able to work in an international professional context
11.	Agile project management; Learning at work; Lean management
12.	Conceptualizing validation of work experience; Innovation and entrepreneurship

What do you think will be the biggest challenges for students in learning about Industry 4.0?

What do you think will be the biggest challenges for teachers in teaching about Industry 4.0?

How do you think the teaching of I 4.0 looks like at your school in 10 years?

Which stakeholders do you think should be taken into account when mapping the competencies to teach Industry 4.0?

Have you experienced anything else that you want to mention?

Questionnaire guide to interviews with stakeholders

The following question guide is based on the answers given to the desk survey. The guide is an inspiration for what you can talk about in the interviews and subsequent reporting. Should any other important topics come up in the discussion, you may note them eventually.

In our European collaboration, we have summarized the technical as the basis for Industry 4.0. e.g. advanced manufacturing solutions, additive manufacturing, augmented reality, simulation, horizontal/vertical integration, industrial internet, cloud, cyber-security, big data and analytics. In most education this skills are supported by soft skills as complex problem solving, communication and Team-working.

In order to substantiate that the students reach the goals, we have considered different didactic approaches. Consider and discuss 2-3 and decide as a group how you think teaching should be organized.

1.	Case-studies/problem-based learning including cross-disciplinary approach – because it fosters independent problem solving and brings a holistic perspective to the task – very much like in professional life; Problem or challenge related to real cases; Real problem-based learning activities that the students know from the companies and where the solutions can be used.
2.	Project work (Future Factory as a multiprofessional learning platform); it fosters soft skills such as collaboration, communication and independent problem solving; Project work, because it brings learners to approach topics from a broader and more industry-related perspective; Project work as learners can choose their own project to develop competencies and develops organizational skills as well; learning to see the whole picture of a project that is being implemented in business
3.	Explorative and cooperative Learning in flipped classroom settings as it fosters the community spirit, engages learners and their curiosity, builds up self-reliability and self-efficacy ; Flipped classroom (eLearning)+
4.	Cross-disciplinary approach would be necessary, to mirror the “reality” students will find at the workplace; Multiform learning; Cross disciplinary approaches are important in Industry 4.0 as it gives a range of perspectives on problems and challenges
5.	VET and/or real environment – we train our students for professional life and this is best achieved in the work place. But sometimes you need a training environment <i>similar</i> to the work place, like a testbed or the demonstrator GTC has constructed for the project Smart Factory; Qualified testimonial could also work, because they could bring into the “classroom” the feeling and needs of a real work environment; Laboratory practice hours; Internship
6.	Design thinking: Working systematically on idea generating and how data can be used in specific projects. Prototyping as it helps learners getting in hands on mindset and helps them getting ideas into actions really fast
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PROFESSIONAL PROFILE

Job description:

List the participant's background and type of industry

If teacher:

School typology:

EQF level(s):

Students' age:

Do you know what does "Industry 4.0" mean?

Yes		No	
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In any case, what does it mean for you?

QUESTIONS

Which didactic approach will you prefer and why, when teaching in Industry 4.0:

Given the priorities they have just made, what consequences will this have for current teaching?

How do you organize teaching based on the choices above? What are the requirements for the teachers' competences?

What do you think will be the biggest challenges for teachers in teaching about Industry 4.0?

How can the teacher ensure close collaboration with the business community so that teaching becomes real-life?

Does the change in Industry 4.0 require separate learning objectives or can they be integrated into current education?

Have you experienced anything else that you want to mention?

Partners

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