access-3DP
Art & Creative Craft Enterprises for Successful Streaming of 3D Printing

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IO2 – 3DP C-TCI Joint Curriculum

- Activity 1 - Training Path definition
- Activity 2 - Definition of Learning Modules and Units
- Activity 3 - Harmonization to the European qualification (ECVET) and Validation

Art & Creative Craft Enterprises for Successful Streaming of 3D Printing

REPORT FOR DEFINING 3D PRINTING C-TCIs VET CURRICULUM

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1 DESCRIPTION OF THE PROJECT (OFFICIAL DESCRIPTION AS IT IS IN THE PROPOSAL)

Additive Manufacturing (or 3D Printing) is one of the technologies under the umbrella of Advanced Manufacturing, which the European Commission has identified as one of the Key Enabling Technologies (KETs).

The creative industries are core elements of the European economy. The people active in its development are talented and flexible with a range of core capabilities that can be developed and improved naturally through practice in their field's activities and lifelong learning. Enterprises in the creative industries are usually small, and often micro enterprises. They find work with clients in sectors that have been traditionally connected to the creative industries for some time, using their flexibility to add value to their products by applying their ability to realise innovative ideas through their work.

Increasingly, these capacities are becoming more relevant to the European Economy as new sectors find out that they are needing the skills provided by creative enterprises and their workers. At the same time new, often disruptive, technologies come to light and consequently require highly skilled creative labour to allow maximum exploitation of capital based thanks to the tools and machines provided by these technologies.

Such technologies are often adoptable by relatively traditional sectors in the economy. However, these sectors often need workers who are ready and competent enough to use the new technologies. On the other hand, when they do have a high level of technical skills, workers often lack the core capacities for creativity, innovation, and an entrepreneurial approach to use technologies such as AM/3D printing. These are working capacities that new technologies require if the capital in the form of tools and machines are to be exploited to the maximum of their potential.

ACCESS-3DP brings together an innovative consortium of 5 partners with experts in 3D Printing and design from the VET, HE world and business organisations from creative industries from 5 EU countries. The partners jointly embrace the following objectives:

- Identification of skills mismatched between the craft and traditional industries with additive manufacturing technologies.

- Use of the skills needs to develop and tailored VET curricula according EU standards to foster the mobility and employability in craft sectors in Europe.
- Improve the competitiveness and efficiency of the traditional sector enterprises through the use of 3D printing technologies.
- Improve the entrepreneurship in craft sectors and Additive Manufacturing sector through better understanding of the 3D printing value chain.
- Evaluate the impact of tailored training about 3D Printing in entrepreneurs and craftsmen.
- Sustain the project results, in the course of time, through the development recommendations for certification.

To achieve such objectives, the partners will develop the following intellectual outputs:

- A report on how VET providers can connect creative and traditional-craft industries.
- A joint VET curriculum according to national and EU standards.
- Learning Modules based on the VET curriculum supported by a MOOC platform.
- A course assessment and qualification resource package in order to support the certification of the ACCESS-3DP Learning Modules and Course.
- A pilot implementation and study of the Learning Modules and Course.

A workshop in the form of a short-term joint staff training event (L/T/T) focusing on innovating crafts through 3DP technology will occur during the last project period and involve Associated Partners. At the same time, 5 Multiplier Events will be organised to enhance the impact of the ACCESS-3DP project by disseminating the project results.

A partnership composed by Higher Education, Business representatives and research will develop approaches to training people in the creative industries that promote that creativity, alongside entrepreneurial thinking and skills for applying innovative ideas in practice. It is vital for anyone working in industries that may apply 3D Printing, to understand the "value chain of 3D printing" and how it may evolve over time. An ACCESS-3DP needs to be given on where in the chain value is added, and how. ACCESS-3DP training materials will empower students to enter the market successfully, and/or to sustain their business successfully.

Increasingly, these capacities are becoming more relevant to the European Economy as new sectors find they need the skills provided by enterprises in creative industries and their workers, and new, often disruptive, technologies come to light that require highly skilled creative labour for there to be maximum exploitation of capital based in the tools and machines of these technologies. Additive manufacturing will be an asset to competitiveness factors, such as flexibility and time to market, among others for the craft and creative industries.

2 INTRODUCTION

The following points summarise the Joint Curriculum design, inform on its classification in reference to EQF, and define training objectives, learning units, and training and assessment methods.

The learning outcomes were analysed and grouped into units. Thirty learning objects were defined as the result.

For each unit, besides "learning outcomes", the fields "objectives", "Learning object number and name," and "contents", recommended training and assessment methods were proposed and recommended training methods established.

Units were grouped into modules, and three training paths were defined for the following profiles:

- Professionals, Workers, Entrepreneurs.
- Students, VET providers, Universities, Unemployed.
- Other relevant Stakeholders (Traditional Sector, Local educational Authorities, Policy-makers).

For providing additional information in numerical form on the relative weight of a unit in relation to a full qualification, ECVET points were attributed to each unit. The effort for the whole learning outcomes achievement was determined, and it was turned into ECVET points. (Attribution of ECVET points considering that 1 point is awarded to 25 hours of training).

After a study of the contents, objectives, and learning outcomes of each unit, the Consortium decided to assign these courses the EQF 5 level.

Table 1: EQF level 5- learning outcomes- knowledge, skill, responsibility and authonomy

KNOWLEDGE	SKILL	RESPONSIBILITY AND AUTHONOMY
Comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge	A comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop the performance of self and others

3 OVERVIEW

Table 2: Overview of the ACCESS-3DP Joint Curriculum

Course Title	ACCESS-3DP
EQF level	Level 5 Post-Secondary Qualification
Target group	1. Professionals, Workers, Entrepreneurs. 2. Students, VET providers, Universities, Unemployed. 3. Other relevant stakeholders from traditional sectors, Local education authorities, Policy-makers.
Methodology	Massive Open-Online Course
Pedagogical approach	PowerPoint, Text, Videos
Language	English (partially in all partners' language)

4 THE STRUCTURE OF THE LEARNING MATERIAL

Table 3: The structure of the ACCESS-3DP learning material

Module Name	Module number	Learning Object number	Learning Object description
Innovation process applied in traditional sector - Design and 3DP	1	1	Basics of the Innovation process
		2	Stages of Innovation Process
		3	Innovation Management and New Product Development
		4	Co-innovation concept
Design Thinking & Skills	2	5	What is Design Thinking?
		6	Principles of Design Thinking
		7	Design Thinking process
		8	Design thinking and business models
		9	Critical Thinking Skills
		10	Benefits of Design Thinking
		11	3DP as a tool to adopt the design thinking methodology for craft and entrepreneur
3D Printing & Production Process	3	12	History of 3D Printing
		13	Description of the Production Process and Available Software
		14	Technologies in 3D Printing
		15	3D Printing Materials
		16	Risk Management
		17	Impact of 3D printing on the supply chain
Current processes - Different fields of application	4	18	3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security
		19	3DP Technologies- Extract the pieces, post-processes
		20	3DP Technologies- Real life examples -TRADITIONAL sectors/field
		21	3DP Technologies- Real life examples- NON-TRADITIONAL modern sectors
		22	Environmental impact and Reusing Potential
Entrepreneurship and 3D Printing - New business Ideas	5	23	What is Entrepreneurship?
		24	Generating and Developing Business ideas 3D Printing Business ideas
		25	New Entrepreneurship ideas using 3D printing
Advanced Industrial Robotics applied in crafts	6	26	Principles fundamentals of robotics
		27	Programming a robot
		28	Criteria for the implementation of a robot
		29	Applications of robots
		30	Coupling AIR with 3DP, Theory and real examples

5 EUROPEAN QUALIFICATION FRAMEWORK

5.1. EQF

The European Qualifications Framework for lifelong learning (EQF) aims at improving the transparency, comparability, and portability of people's qualifications. The EQF was set up in 2008 as a common reference framework of qualifications, expressed as learning outcomes at increasing proficiency levels. The Framework serves as a translation device between different qualifications systems and their levels in EU countries. It is intended to benefit learners, workers, jobseekers, employers, trade unions, education and training providers, qualification recognition bodies, government authorities and international organisations.

Three categories define the learning outcomes:

- **Knowledge** is defined as learning and the assimilation of concepts, principles, theories, and practices. Acquisition of knowledge takes place in various settings: in the educational process, at work, and in the context of private and social life.
- **Skills** may be cognitive or practical.
- **Competencies** are classified in terms of complexity, autonomy, and responsibility, and it is about the ability to put in practice the skills and knowledge acquired.

European Qualifications Framework - a bridge between national qualifications systems

The core of the EQF is its eight reference levels defined in terms of learning outcomes, i.e., knowledge, skills, and competence. Learning outcomes express what individuals know, understand, and can do at the end of a learning process.

Countries develop national qualifications frameworks (NQFs) to implement the EQF. Levels of national qualifications will be placed at one of the main reference levels, ranging from basic (Level 1) to advanced (Level 8). This will enable much easier comparison between national qualifications and should also mean that people do not have to repeat their learning if they move to another country.

To compare EQF in different countries, see https://europa.eu/europass/en/compare-qualifications- it is possible to see how national qualifications levels of countries that have already finalised their referencing process have been linked to the EQF.

Below are described the knowledge, skills, and competencies of all eight levels by which the EQF is **composed:**

Table 4: Eight levels of EQF

Level	Knowledge	Skills	Competence
	In the context of EQF, knowledge is described as theoretical and/or factual.	**In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments).**	**In the context of EQF, competence is described in terms of responsibility and autonomy as the ability of the learner to apply knowledge and skills autonomously and with responsibility.**
Level 1	Basic general knowledge.	Basic skills required to carry out simple tasks.	Work or study under direct supervision in a structured context.
Level 2	Basic factual knowledge of a field of work or study.	Basic cognitive and practical skills are required to use relevant information to carry out tasks and to solve routine problems using simple rules and tools.	Work or study under supervision with some autonomy.
Level 3	Knowledge of facts, principles, processes and general concepts in a field of work or study.	A range of cognitive and practical skills is required to accomplish tasks and solve problems by selecting and applying basic methods, tools, materials and information.	Take responsibility for completing tasks in work or study; adapt own behaviour to circumstances in solving problems.
Level 4	Factual and theoretical knowledge in broad contexts within a field of work or study.	A range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study.	Exercise self-management within the guidelines of work or study contexts that are usually predictable but are subject to change; supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities.
Level 5	Comprehensive, specialised, factual, and theoretical knowledge within a field of work or study and an awareness of the boundaries of that	A comprehensive range of cognitive and practical skills is required to develop creative solutions to abstract problems.	Exercise management and supervision in contexts of work or study activities where there is unpredictable change; review and develop the performance of self and

	knowledge.		others.
Level 6	Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles.	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study.	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups.
Level 7	Highly specialised knowledge, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research Critical awareness of knowledge issues in a field and at the interface between different fields.	Specialised problem-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields.	Manage and transform work or study contexts that are complex, unpredictable and require new strategic approaches; take responsibility for contributing to professional knowledge and practice and/or for reviewing the strategic performance of teams.
Level 8	Knowledge at the most advanced frontier of a field of work or study and at the interface between fields.	The most advanced and specialised skills and techniques, including synthesis and evaluation, required to solve critical problems in research and/or innovation and to extend and redefine existing knowledge or professional practice.	Demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity, and sustained commitment to the development of new ideas or processes at the forefront of work or study contexts, including research.

Why the EQF is important

The main purpose of the EQF is to make qualifications more readable and understandable across countries and systems. This is important to support cross-border mobility of learners and workers and lifelong learning across Europe.

The EQF has been the catalyst for the development of comprehensive national qualification frameworks based on learning outcomes. All countries committed to the EQF consider such national frameworks necessary to make their qualifications comparable across sectors and countries. The EQF is voluntary, and the member countries are not obliged to cross-reference their frameworks but the number of completed cross-references is expected to increase in the near future. Covering qualifications at all levels and in all subsystems of education and training, the EQF provides a comprehensive overview over qualifications in the 39 European countries currently involved in its

implementation.

5.2. ECVET POINTS

The European Credit System for Vocational Education and Training (ECVET) is a European instrument designed to support lifelong learning, the mobility of learners and the flexibility of learning pathways to achieve qualifications. The adoption and implementation of ECVET in the participating countries is voluntary.

The ECVET is a technical framework for the transfer, recognition and accumulation of individuals' learning outcomes used in order to achieve a qualification.

The main aim of ECVET is the improvement of learners' mobility in three dimensions:

- Geographical mobility.
- Professional mobility in the vertical as well as in the lateral dimension, i.e. between occupational areas as well as between labour markets.
- Educational mobility, i.e. formal, non-formal as well as informal learning shall be integrated in one system of learning, thereby facilitating the transition between the different educational systems.

This credit system has been launched following a Recommendation of the European Parliament and the Council in 2009. The reasons behind the recommendation were mainly the difficulty to get validation and recognition of work-related skills, to increase the attractiveness of moving to other countries and the need to create a more homogenous compatible vocational education and training system in Europe.

It is an instrument for describing qualifications in terms of units of learning outcomes according to the concepts of knowledge, skills and competencies. These units, which are associated with specific numbers of credit points, can be transferred and accumulated. ECVET intends that these accredited units of learning outcomes can be accumulated across countries and learning contexts so that they may lead to a full qualification by the national legislation.

It also allows VET graduates to have more job opportunities while giving employers confidence in the experience of the person they want to hire. Furthermore, the qualifications assigned in the ECVET system have to be described in units of Learning Outcomes and associated ECVET points. There is a process to make sure the Learning Outcomes are assessed, validated, recognised, and transferred and accumulated. The partnerships that will be created thanks to the ECVET system are supported by additional documents: the memorandum of understanding and learning agreements.

It is important to note that in the ECVET system, there is no automatic recognition of either learning outcomes or points. Its application for a given qualification is in accordance with the legislation, rules and regulations applicable in the Member States.

The **main ECVET** concepts and principles are:

- Learning outcomes are statements of knowledge, skills, and competence that can be achieved in various learning contexts.

- Units of learning outcomes that are components of qualifications. Units can be assessed, validated, and recognised.
- ECVET points which provide additional information about units and qualifications in a numerical form.
- Credit that is given for assessed and documented learning outcomes of a learner.
- Credit can be transferred to other contexts and accumulated to achieve a qualification based on participating countries' qualifications standards and regulations.
- Mutual trust and partnership among participating organisations. These are expressed in Memoranda of Understanding and Learning Agreements.

5.3. EQAVET

The EQAVET (European Quality Assurance Reference Framework) is a European-wide framework to support vocational education and training quality assurance (VET). EQAVET emerged from the 2009 Recommendation of the European Parliament and Council, which invited Member States to use indicative descriptors and indicators to strengthen the quality of VET provision.

EQAVET supports the implementation of the 2020 Recommendation on VET for sustainable competitiveness, social fairness and resilience. The VET Recommendation describes how EQAVET can strengthen the quality of initial and continuing VET and presents the complete EQAVET Framework. The EQAVET is a voluntary system made for the use of public institutions and other bodies. Its goals are the promotion and monitoring of the continuous improvement of VET systems. It also offers VET providers a straightforward way to improve their systems.

EQAVET is based on a four-stage cycle:

1. **Purpose and plan:** set up clear, appropriate and measurable goals.

2. **Implementation**: establish procedures to achieve the goals.

3. **Assessment and Evaluation**: design mechanisms to evaluate the data collected about the activities that have been done to achieve the goals.

4. **Review**: after processing feedbacks, the stakeholders analyze to comprehend how to improve the stages.

The EQAVET Framework can be used by VET providers and in VET systems to support:

- Learning environments (e.g. school-based provision, work-based learning, apprenticeships, formal, informal and non-formal provision).
- All types of learning (e.g. digital, face-to-face and blended).
- Public and private sector VET providers.
- VET awards and qualifications at all levels of the European Qualifications Framework.

The implementation of the Recommendation is supported by members of the EQAVET network, National Reference Points and the European Secretariat for EQAVET. The National Reference Points bring together relevant stakeholders at the national and regional level to:

- Implement and further develop the EQAVET framework.
- Inform and mobilise a wide range of stakeholders, including Centres of Vocational Excellence, to contribute to implementing the EQAVET framework.
- Support self-evaluation as one way to measure success and identify areas for improvement, including the digital readiness of VET systems and institutions.
- Participate actively in the EQAVET network.
- Provide updated descriptions of the national quality assurance arrangements based on EQAVET.
- Engage in EU-level peer review to enhance the transparency and consistency of quality assurance arrangements and reinforce trust between the Member States.

6 National Framework

National Qualifications Frameworks (NQFs) classify qualifications by level based on learning outcomes. This classification reflects the content and profile of qualifications - that is, what the holder of a certificate or diploma is expected to know, understand, and be able to do. The learning outcomes approach also ensures that education and training subsystems are open to one another. Thus, it allows people to move more easily between education and training institutions and sectors.

Frameworks help to make qualifications easier to understand and compare. They can also encourage countries to rethink and reform national policy and practice on education, training, and lifelong learning.

The primary catalyst for developing comprehensive national qualification frameworks in Europe has been the European Qualifications Framework (EQF). All countries committed to the EQF are developing or implementing national frameworks mainly covering all levels and types of qualifications: the 28 Member States, Iceland, Liechtenstein, Norway, Switzerland, Albania, Bosnia and Herzegovina, the former Yugoslav Republic of Macedonia, Montenegro, Serbia, and Turkey.

The development of NQF in Europe also reflects the Bologna process and the agreement to implement qualifications frameworks in the European Higher Education Area (QF-EHEA). All countries implementing the EQF are participating in this process. In the following subsections, we will go deeply into the national qualifications framework of partners projects.

6.1 National Framework – Qualification System in Slovenia

The Slovenian Qualifications Framework Act (2015, sl) introduced the Slovenian Qualifications Framework (SQF) at the end of 2015. The Framework is set out as a single system of classifying

qualifications to levels according to criteria specified by law and learning outcomes. Furthermore, the Framework was set out to facilitate the comparison of national qualifications with the qualifications of the EQF and the QF-EHEA.

The SQF aims to obtain transparency and identification of qualifications at the national and EU levels.

The main objectives of the SQF are to:

- Support lifelong learning.
- Connect and coordinate the Slovenian qualifications subsystems.
- Improve the transparency, accessibility, and quality of qualifications in the labour market and civil society.

By law, the Institute of the Republic of Slovenia for Vocational Education and Training (CPI) became the national coordination point for the SQF and EQF. The national coordination point is tasked with:

- Ensuring access to information on and the promotion of the SQF and EQF managing the process of approving and registering qualifications.
- Coordinating the positioning of the SQF within the EQF.
- Cooperating with relevant EU institutions, among others.

The national coordination point also provides administrative and general support to the seven-member expert committee appointed by the Minister of Labour. This expert committee brings together representatives of three ministries (in charge of labour, education, and economic development) and employers and employees. Among other tasks, the expert committee defines standards for the integration of additional qualifications into the SQF. The committee also monitors the SQF, EQF and the European Higher Education Area (EHEA).

SQF conception

Turning to the substance of the SQF, the system includes formal education qualifications (at all levels) and qualifications obtained outside the system of formal education (National Vocational Qualifications and supplementary qualifications).

In line with the EU-level policies, learning outcomes represent the core of the SQF. This contributes to the comparability and transparency of qualification systems, lifelong learning, recognition of non-formal and informal learning, quality assurance and better integration between education and the labour market.

The SQF classifies the qualifications into ten levels. The classification applies the appropriate level descriptors. The individual-level descriptor includes three categories of learning results:

- **Knowledge** is defined as learning and the assimilation of concepts, principles, theories and practices. Acquisition of knowledge takes place in various settings: in the educational process, at work and in the context of private and social life.

- **Skills**, the second outcome, may be cognitive (such as the use of logical, intuitive, and creative thinking) or practical (for instance, manual, creative skills, use of materials, tools and instruments).
- Lastly, **competencies** refer to using and integrating knowledge and skills in educational, professional, and personal situations. They are classified in terms of complexity, autonomy, and responsibility. They distinguish between generic and vocation or profession-specific competencies.

Other components of the SQF are:

- Qualifications framework as a tabular presentation of categories and types of qualifications at ten qualification levels.
- Methodology of description and referencing of qualifications.
- Register of SQF qualifications.

Referencing the SQF to EQF and EHEA

The 10-level SQF is related to eight EQF levels through descriptors for both frameworks. SQF descriptors from levels 6 to 10 are related to the EHEA.

Table 5: NQF in Slovenia

Slovenia NQF	EQF Levels
NQF 10 Doctoral degree (Diploma o doktoratu znanosti) **NQF 9** Post-graduate research Master of science degree (Diploma o magisteriju znanosti)Specialisation diploma following academic higher education (Diploma o specializaciji	EQF Level 8
NQF 8 Master degree (Diploma o strokovnem magisteriju) Specialisation diploma following pre-Bologna professional higher education (Diploma o specializaciji) Pre-Bologna diploma of academic higher education	EQF Level 7
NQF 7 Academic bachelor diploma (Diploma o izobraževanju prve stopnje – univerzitetna, UN) Professional bachelor diploma (Diploma o izobrazevanju visokem strokovnem, VS) Pre-Bologna professional higher education diploma (Diploma o visokem strokovnem izobraževanju Specialisation diploma following old short-	EQF Level 6

cycle higher education (Diploma o specializaciji) Certificate of supplementary qualification (SQF level 7)	
NQF 6 Short-cycle higher vocational diploma (Diploma o višji strokovni izobrazbi) Old short-cycle higher vocational diploma (Diploma o višješolski izobrazbi) NVQ certificate (level 6) Certificate of supplementary qualification (SQF level 6)	EQF Level 5
NQF 5 Vocational matura certificate (Secondary technical education, four years) (Spričevalo o poklicni mature) General matura certificate (Spričevalo o splošni mature) Master craftsman's examination certificate (Spričevalo o opravljenem mojstrskem izpitu) Foreman's examination certificate (Spričevalo o opravljenem delovodskem izpitu) Managerial examination certificate (Spričevalo o opravljenem poslovodskem izpitu) NVQ certificate (level 5) Certificate of supplementary qualification (SQF level 5) NQF 4 Final examination certificate (Secondary vocational education, three years) (Spričevalo o zaključnem izpitu, Srednja poklicna izobrazba) NVQ (level 4) Certificate of supplementary qualification (SQF level 4)	EQF Level 4
NQF 3 Final examination certificate (Lower vocational education, two years) (Spričevalo o zaključnem izpitu NVQ (level 3)	EQF Level 3
NQF 2 Elementary school leaving certificate (nine years) (Zaključno spričevalo osnovne šole) NVQ (level 2)	EQF Level 2
NQF 1 Certificate of completing grades 7 or 8 of elementary education (Potrdilo o izpolnjeni osnovnošolski obveznosti) Elementary school leaving certificate (Zaključno spričevalo osnovne šole)	EQF Level 1

6.2 National Framework – Qualification System in Spain

In 2009, the Spanish Government entrusted the Ministry of Education to draw up the **Spanish Qualifications Framework**. In 2011, the Sustainable Economic Act demanded the creation of this Framework to encourage and increase the mobility of students and workers.

The Spanish Qualifications Framework is a national qualifications framework (degrees, diplomas and certificates) that includes lifelong learning. It is a structure that organises qualifications according to levels and comprises the most basic to the most complex learning. It, therefore, covers general and adult education, vocational education and training, and higher education.

The Spanish Qualifications Framework aims to correlate and coordinate the different subsystems of education and training, including the qualifications obtained in compulsory, post-secondary and higher education, and integrate non-formal and informal learning validation.

Main objectives of the Spanish Qualifications Framework

- Make qualifications more understandable by describing them in terms of learning outcomes.
- Improve citizens' information on national qualifications, as well as facilitate and promote mobility.
- Support lifelong learning and correlate initial vocational training and vocational training for employment, as well as improve access and participation in this type of training, especially for people with some kind of disability.
- Facilitate the identification, validation, and recognition of all types of learning outcomes, including those related to non-formal and informal learning.
- Facilitate transition and progression between the different training subsystems.
- Develop procedures for the recognition of non-formal learning.
- Reduce early school leaving.

Key actors

Through the General Secretariat for Vocational Training, the Ministry of Education and Vocational Training coordinates the development and implementation of the Spanish Qualifications Framework in cooperation with the Ministries of Employment and Social Economy, of Industry, Trade and Tourism, and of Economic Affairs and Digital Transformation.

Although the Ministry of Education and Vocational Training is in charge of the drafting and coordination of the actions and the necessary regulations for its implementation, as well as the body responsible for guiding its successful implementation through the National Coordination Point, its actual implementation is the responsibility of public authorities and the different social actors.

A Royal Decree that will establish the foundations for its implementation is currently under

preparation.

The establishment of a committee including social actors, ministries, trade unions and the most representative employers' associations, and experts in vocational qualifications of different sectors, is recommended. This committee would be in charge of deciding on the assignment of qualifications to the levels of the Spanish Qualifications Framework, which should be based on three criteria:

- Comparability between the descriptors of the qualifications, defined as learning outcomes, and the level descriptors of the Spanish Qualifications Framework.
- Implementation of a common quality assurance system in higher education and vocational training.
- Public consultation with the bodies and organisations involved in the design of qualifications in their respective sectors.

The intention is to assign formal education qualifications to the levels of the Spanish Qualifications Framework in the first place. The assignment of qualifications related to validating non-formal and informal learning is expected to be more complicated.

Structure of the Spanish Qualifications Framework: levels and learning outcomes

The proposed Framework has eight levels and the level descriptors, defined in terms of knowledge, skills, and competencies. It is inspired by the European Qualifications Framework for Lifelong Learning level descriptors adapted to the national context.

The Spanish Qualifications Framework for Lifelong Learning (MECU) aims to promote greater mobility for citizens in their learning, training and work environment, fulfilling the commitment derived from the 2030 Agenda and its objectives, and trying to guarantee an inclusive, equitable and quality education, as well as the promotion of lifelong learning. This Framework is a structure for organising qualifications by levels, ranging from the most basic learning to the most complex. Therefore, it covers formal learning processes (general and adult education, vocational education and training, and higher education) and non-formal and informal learning processes. The Spanish Framework is linked to the EQF and completes the regulation of the Spanish qualifications framework, together with the Spanish Qualifications Framework for Higher Education (MECES). The levels into which the Spanish Qualifications Framework for Lifelong Learning is structured, together with the levels of the Spanish Qualifications Framework for Higher Education, complete the eight reference levels of the European Qualifications Framework for Lifelong Learning. Each level is associated with learning outcomes descriptors, classified in knowledge, skills, autonomy, and responsibility, according to the European Qualifications Framework for Lifelong Learning, but adapted to the national context. Based on the European recommendation to facilitate the progressive incorporation of non-formal learning into the Framework, some levels have been subdivided.

Table 6: Spanish NQF

EQF	*MECES*		*CNCP*	
Level	Level	Current qualifications	Level	Current qualifications
1			1	Operators
2				
3			2	Middle-level technician
4				
5	1	- Higher Technician of VET - Superior Technician of Plastic Arts - Superior Sports technician	3	High-level technician
6	2	- Graduate Degree - Higher Artistic Education Diploma Degree	4	Degree
7	3	- University Master's degree - Bachelor's degree in 300 ECTS (60 with Master level) - Master's Degree in Artistic Education	5	Master
8	4	Doctor	6	Doctor

6.3 National Framework – Qualification System in Portugal

In Portugal, the educational system uses the EQF to describe national qualifications in terms of learning outcomes.

The creation of the NQF, which was undertaken as part of the Education and Training System reform process and the creation of the National Qualifications System, was based on the following assumptions:

- The need to integrate and coordinate qualifications obtained within the different subsystems of education and training (vocational training, higher education) within a single framework.
- The importance of valuing and considering competencies acquired in non-formal and informal contexts.

- Improved legibility, transparency and comparability of qualifications;
- Respecting dual certification particularly associated with upper-secondary qualifications;
- Ensuring coordination with the European Qualifications Framework involves using the EQF as a reference tool to compare the qualifications levels of different qualifications systems in terms of lifelong learning.

The NQF is structured as follows:

Table 7: Portugal NQF

Portugal NQF level	Students age (indicative)	EQF Levels
NQF 8 Doctoral degree (Doutoramento) Doctorate		**EQF Level 8**
NQF 7 Master degree (Mestrado)		**EQF Level 7**
NQF 6 Bachelor degree (Licenciatura)	From 18 years old	**EQF Level 6**
NQF 5 Non-higher, post-secondary qualification with credits to continue to higher education-level studies (Diploma de Especialização Tecnológica)	18-20 years old	**EQF Level 5**
NQF 4 Upper-secondary education obtained via dual certification or upper-secondary education geared towards further studies in higher education with vocational internship – minimum 6 months Upper secondary education and professional certification (Ensino secundário obtido por percursos de dupla certificação) Upper secondary education and professional internship – minimum six months (Ensino secundário vocacionado para prosseguimento de estudos de nível superior acrescido de estágio profissional – mínimo de seis meses)	15-18 years old on	**EQF Level 4**

NQF 3 Upper-secondary education geared towards further studies in higher education Upper secondary general education school leaving certificate (Ensino secundário vocacionado para prosseguimento de estudos de nível superior)	15-18 years old on	**EQF Level 3**
NQF 2 3rd cycle of primary education obtained in primary education or via dual certification Third cycle of basic education (3º ciclo do ensino básico obtido no ensino regular) Third cycle of basic education and professional certification (3º ciclo do ensino básico obtido por percursos de dupla certificação)	12-15 years old	**EQF Level 2**
NQF 1 2nd cycle of primary education(2º ciclo do ensino básico)	10-12 years old	**EQF Level 1**

At the same time, in Portugal, the National Qualifications Agency (ANQ), currently named National Qualification and Professional Education Agency, (ANQEP, IP) was created, aiming at coordinating the NQF, jointly with other competent bodies in the area of vocational education and training, in particular the Ministry of Education and Ministry of Labour and Solidarity. These duties are performed in conjunction with the Directorate General of Higher Education regarding levels 5-8 of the NQF. The NQF covers all programs leading to obtaining formal qualifications, regardless of being supervised by the Ministry of Education or the Ministry of Labour.

The National Qualifications' Catalogue (NQC) includes school-based VET programs (although with a work-based learning component), dependent on the Ministry of Education, and work-based VET programs financed by the IEFP – Employment and Vocational Training Institute, dependent on the Ministry of Labour.

The National Catalogue of Qualifications:

- Is a dynamic instrument for the strategic management of non-higher national qualifications (from level 2 to 5).
- Is managed by ANQEP.
- Is the regulation of the double certification training offer.

- Integrates qualification references for double certification training and processes of recognition, validation, and certification of competencies (RVCC).
- Is the promotion of the effectiveness of public financing.
- Includes many qualifications for 39 education and training areas and presents the associated Professional Profile and Training References for each stuff. (310 qualifications: 110 Level 2 (operator); 156 Level 4 (Technician); 44 Level 5 (Specialized Technician), 22 adapted qualification (for people with special needs), 30 qualifications for TCLF, modularised qualifications.

ANQEP IP coordinated the National Qualifications' Catalogue, where all the qualifications are included for all the sectors. ANQEP IP through the National Skills Councils (dedicated to each sector of economic activity – for instance, National Skills Councils for TCLF) certifies the profile and curriculum and conducts it to an approved certified Qualification, included in the National Catalogue.

Regarding the offer within Professional Training Schemes, IEFP – Portuguese Employment and Professional Training Institute, a public agency connected to the Ministry of Labour and Solidarity, is the national authority responsible for the management.

Regarding the other offer connected to school-based education, even including apprenticeship schemes, the responsible entity is the General Directorate of Education.

In January 2011, it was established that all certificates and diplomas issued from October 1st, 2010, onwards, and which confer a qualification featured in the NQF, must include a reference to the respective level of qualification, which provides more excellent legibility and transparency in understanding qualifications obtained in the system.

6.4 National Framework – Qualification System in France

In 2018, a new French national framework for professional qualifications was created to adopt law no. 2018-771 of 5 September (Art. 36) on employees' freedom to choose their professional future.

The new national qualifications framework has **eight levels**, similarly to the EQF. Indeed, the adoption of the new French system is aiming to improve the comparability between the European and French frameworks and for the French qualifications framework to be more in line with the European one (the old French system only had 5 levels, no equivalents for the lowest levels 1 and 2 of the EQF and the French highest level was equivalent to levels 7 and 8 in the European system).

Each level of qualification is fixed by the result of the balance between the three following descriptors / criteria, which are connected to the labor market:

1. **Knowledge** (progression in expertise to carry out the professional activities of the level (processes, materials, terminology of one or several fields, theoretical knowledge)).
2. **Expertise** (progression to carry out professional activities in relation with the level: complexity and technicity of a task, of activity in a process, the level of mastery of the professional activities, the ability to use a range of abilities (practical and cognitive ones),

expertise in the field of communication and interpersonal relationships in a professional context, the ability to transfer skills).

3. **Responsibility and autonomy** (progression in the following fields: work organisation, response to hazard, comprehension of the complexity, understanding of the overlapping with other professional fields, enabling to organise one's work, to correct it or to give indications to supervised staff, the participation to collective work, the level of supervision).

With the law of 2018, the French Government created a new public institution named France Compétence to oversee the regulation of the professional training market. France Compétence is under the supervision of the Ministry for Employment and Professional Training, with a Board composed of representatives of the State, the Regions and social partners. **France Compétence acts as a national coordination point for the quality of professional training and as the national coordination point for implementing the EQF**.

French qualifications are registered with their level and classified at the **national register for professional qualifications** (also known as RNCP in French), a national database managed by France Compétence.

There are only 2 ways to register qualifications in France:

- **Registration by law:** ministries create qualifications after having a commission with representatives of social partners and ministries. For Higher Education diplomas, it is an obligation to have registration by law.
- **Registration on demand:** qualifications are accredited by France Compétence after analysing and assenting the "commission nationale de la certification professionnelle", chaired by an independent person.

Qualifications are expressed in learning outcomes and are based on three standards: standard of activities, the standard of competencies and the standard of assessment.

They must be composed of units/competencies blocks to facilitate lifelong learning.

Under the responsibility of France Compétence, pathways are also possible between blocks of competencies registered in the RNCP and qualifications registered in another national repertory with qualifications without level.

Table 8: France NQF level

France NQF level	EQF Level
NQF 8 Doctoral programmes (Doctorats)	EQF Level 8
NQF 7 Master degrees (Master) Master degrees in engineering (Titre d'ingénieur diplômé) Other vocational qualifications level 7 "by law" Professional qualifications 7 (Including sectoral qualifications CQP)	EQF Level 7

NQF 6 Bachelor degrees (Licences) Vocational bachelor (Licence professionnelle) Bachelor universitaire de technologie (BUT) Bachelor en sciences et en ingénièrie (Bachelor degree) Professional qualifications level 6 (Including sectoral qualifications CQP) Other vocational qualifications level 6 "by law"	EQF Level 6
NQF 5 Undergraduate technician certificate (Brevet de technicien supérieur – BTS) Undergraduate technician certificates in agriculture (Brevet de technicien supérieur agricole – BTSA) Undergraduate certificates in technology (Diplôme universitaire de technologie – DUT) Mastercraftsman qualifications (chambers of trades) Professional qualifications level 5 (including sectoral qualifications CQP) Other vocational qualifications level 5 "by law"	EQF Level 5
NQF 4 Professional certificates (Brevets professionnels) Technician certificates (Brevets de technicien) Other vocational qualfications level 4 "by law" Capacité en droit Baccalauréates (général, technologique and vocational) Professional qualifications level 4 (Including sectoral qualifications CQP)	EQF Level 4
NQF 3 Secondary vocational certificates (Certificat d'aptitude professionnelle – CAP; Brevet d'études professionnelles – BEP) Secondary vocational certificates in agriculture (Certificat d'aptitude professionnelle agricole – CAPA; Brevet d'études professionnelles agricoles – BEP) Other vocational qualifications level3 "by law" Professional qualifications 3 (Including sectoral qualifications CQP)	EQF Level 3
NQF 2 No qualifications registers available yet	EQF Level 2

NQF 1 No comparison possible (no descriptors)	EQF Level 1

Each qualification within the RNCP is described in learning outcomes/professional purpose and not just a diploma. Therefore, each qualification must be accessible by validating learning outcomes, whether formal, non-formal or informal, i.e. through the Validation of Acquired Experience (VAE) system. VAE is one of the pillars of the French lifelong learning policy: it is a measure that enables anyone, regardless of age, level of education or status, to have their experience validated to obtain a professional qualification. Three years of experience relevant to the content of the qualification concerned are required.

6.5 National Framework – Qualification System in Slovakia

The history of the Slovak Qualifications Framework dates back to 2009, when the Slovak Government made a legislative commitment to its creation by adopting the Government Resolution No. 105/2009 of 4 February 2009. The Resolution announced the steps necessary for building the national structures and started processes leading to its full implementation.

The characteristic features of SKKR are:

- SKKR is a comprehensive framework; it fully covers qualifications awarded in the general education, vocational education, higher education and further education system in Slovakia (formal school education, non-formal/further/ education and informal learning).
- SKKR levels are characterised by descriptors.
- The structure of the SKKR levels is simple, clear, easy to understand and shows clear relationships between qualifications.
- Qualifications included into the Framework are based on learning outcomes.
- Qualifications included into the Framework are quality assured.
- Qualifications are developed in close cooperation of stakeholders (government authorities, employers, NGOs, educational institutions).
- It allows the development of procedures for validation of prior learning leading to a qualification.

The roles of SKKR were defined as:

- **Communication role:** to inform in a transparent, clear, understandable way about national qualifications, their characteristics and relationships.
- **Transformation role**: to contribute to the revision and change of the system of recognition and validation of non-formal and informal learning.

- **Regulatory role**: to support monitoring of the process of identification and description of qualifications in the form of standards, levelling to SKKR and monitoring and regulation of the system of recognition and validation of qualifications.

The objectives of the Slovak Qualifications Framework are:

- Better transparency of the education system both in the national and international context.
- Increased transparency of qualifications, which are described in terms of learning outcomes.
- Easier transfer of labour market and social needs into the content of education and training.
- Strengthened relationship and a common approach between all stakeholders involved in education and, at the same time, developing general principles for validation and recognition of qualifications.
- Modernisation of education through the application of quality assurance procedures in acquiring qualifications, and
- Increased quality of verification and recognition of qualifications. SKKR is accessible at www.kvalifikacie.sk where a list of qualifications with assigned SKKR level is available.

The National Qualifications Framework of the Slovak Republic **is based on eight qualification levels**, which is a structure approved by the ministry of education in March 2011. Descriptors within the Slovak qualification framework, which were approved in May 2015, were subsequently reviewed. The SKKR is described in a grid containing eight reference levels of knowledge, skills and competencies defined by national descriptors.

Table 9: Slovakian NQF level

Slovakian NQF level	**EQF Level**
NQF 8 Diploma (Vysokoškolský diplom) + Certificate of State exam (Vysvedčenie o štátnej skúške) + Diploma supplement (Dodatok k diplomu)	EQF Level 8
NQF 7 Diploma (Vysokoškolský diplom) + Certificate of State exam (Vysvedčenie o štátnej skúške) + Diploma supplement (Dodatok k diplomu) Certificate of qualification (Osvedčenie o kvalifikácii)	EQF Level 7
NQF 6 Diploma (Vysokoškolský diplom) + Certificate of State exam (Vysvedčenie o štátnej skúške) + Diploma supplement (Dodatok k diplomu) Certificate of qualification (Osvedčenie o kvalifikácii)	EQF Level 6
NQF 5 Maturita certificate (Vysvedčenie o maturitnej skúške) + Certificate of apprenticeship	EQF Level 5

(Výučný list) Maturita certificate (Vysvedčenie o maturitnej skúške) Certificate of final post-secondary exam (Vysvečenie o absolventskej skúške) + Absolutorium diploma (Absolventský diplom) Certificate of qualification (Osvedčenie o kvalifikácii)	
NQF 4 Maturita certificate (Vysvedčenie o maturitnej skúške) + Certificate of apprenticeship (Výučný list) Maturita certificate (Vysvedčenie o maturitnej skúške) Certificate of qualification (Osvedčenie o kvalifikácii	EQF Level 4
NQF 3 "Certificate of final exam (Vysvedčenie o záverečnej skúške) + Certificate of apprenticeship (Výučný list) "Certificate of qualification (Osvedčenie o kvalifikácii)	EQF Level 3
NQF 2 Lower secondary education certificate with supplement (Vysvedčenie s doložkou) Certificate of final exam (Vysvedčenie o záverečnej skúške) + Certificate of apprenticeship (Výučný list) Certificate of qualification (Osvedčenie o kvalifikácii)	EQF Level 2
NQF 1 Primary education certificate with supplement (Vysvedčenie s doložkou)	EQF Level 1

Assessment and subsequent inclusion of educational programmes, study programmes, and educational activities and qualifications are based on the work group's professional output and the Slovak qualification framework descriptors. The work group members, who work directly under the National coordination unit to implement the European qualification framework, are classified into appropriate levels of the Slovak qualification framework. Since 2014, this unit has operated at the State Institute of Professional Education.

During the last years, Slovakia has been transforming the VET system to create a closer link to the needs of the labour market.

Preparation of the National Qualifications Framework is subject to parallel the ongoing creation of the National System of Occupations (NSO) and the National System of Qualifications (NSQ). The

NSQ is a publicly accessible register of all full and partial qualifications, confirmed, differed and recognised at the territory of the Slovak Republic. NSQ aims to support the interlink of formal and non-formal education, compare results of education achieved by various forms of teaching and learning, and compare qualification levels in the Slovak Republic and other EU countries. At the same time, it will inform the general public of all nationally recognised qualifications.

The essence of the parallel creation of NSQ and NQF is a proper interconnection of education results and individual qualifications. The NSQ will enable recognition of real knowledge, abilities and skills independently of the forms of education, transfer of the demands of the labour market to education, public information of all nationally recognised qualifications, compatibility of qualifications levels in the Slovak Republic and other EU member countries. Currently, there are the first 1000 qualifications described in NSQ.

The National System of Occupations (NSO) determines the professional skills and practical experience necessary for performing work activities at labour market posts. The Ministry of Labour, Social Affairs and Family of the Slovak Republic, in cooperation with public administration authorities, local self-government bodies, employers, representatives of employers and representatives of trade unions, contributes to the NSO output.

The main goal of NSO is to update and maintain the system that will enable access to detailed information on the labour market (current needs of employers, description of occupations and requirements of pursuing them) and will contribute to improvement of interlink between the employers' demands and education and training for the labour market. The National System of Occupations will be the basic system framework for updating the National Qualifications System.

ECVET is intended to facilitate learning outcomes by national legislation in the Framework of mobility to achieve a qualification. Thus, in conclusion, it is possible to declare that not all countries are ready for ECVET implementation at the same level. There is still work for complete integration, mainly with those without a credit system.

The EQF is a common European reference framework to make qualifications more readable and understandable across European countries and systems. The comparative analysis developed for each national qualification system of the Consortium stressed the need to provide a clear regulatory framework for European statements in terms of ECVET and EQF. As it has been defined, the core of the EQF its eight reference levels are defined in terms of learning outcomes, i.e. knowledge, skills and competencies. Each country has developed NQFs to implement the EQF.

7 LEARNING OUTCOMES

7.1 MAIN FINDINGS AND RESULTS FROM THE KEY STUDY

In the Study report on how VET providers can innovate and interconnect traditional and creative craft industries through study developed within IO1, the third part of the report is dedicated to analysing the use and needs of 3DP, which has been carried out by directly questioning the final

beneficiaries of the training offer 3DP and AIRs. The replies were provided by 46 European businesses, based in 7 European countries, which either are already using this technology or are potentially interested in adopting it, but also by other types of organisations such as training providers on 3DP and AIRs and similar stakeholders. Considering their feedbacks, the main recommendations and proposals to consider in the development of the ACCESS-3DP Joint curriculum are as follows:

A) Regarding the **content of the training**:

- Explain and show the added value of 3DP and its applications to businesses and provide information to give visibility to the network of actors who can be mobilised to use 3DP.
- Rely on the concrete and varied uses of 3DP existing to arouse interest and show the possible opportunities for traditional companies.
- Rely on the needs identified by companies to build the content of training modules: design and software modelling, 3DP as a source of creativity, multifactorial approach to their business project, and the technology available (market-uses / technical/financial), choice of the suitable material for their 3DP project.
- Raise awareness and inform on the security issues related to the use of 3DP machines.

B) Regarding the **form of the training**:

- Raise awareness on the training providers offering training on 3DP and AIRs and facilitate the link between craft entrepreneurs and the local economy and innovation ecosystem actors to support the development of a 3DP project.
- Give examples of best practices from the craft sector to show the enterprises how 3DP can be coupled with robotic technologies to generate new solutions and applications for production automation. Then, highlight the benefits of associating 3DP and AIR.
- Integrate practical workshops into the training program.
- Raise the awareness and skills on AM by favouring highly operational training, including scenarios and 3DP practical examples and/or exercises.

C) Regarding the **access to the training:**

- Allow for the choice on different levels of training, with a focus on the basic and intermediate levels.

7.2 IDENTIFIED LEARNING OUTCOMES

Table 10: Learning Outcomes module 1 - Innovation process applied in the traditional sector as design and 3DP

KNOWLEDGE	SKILLS	COMPETENCES
Have knowledge about Innovation concepts and objectives, and challenges through the innovation process.	Be able to describe the different types of innovation, the benefits, and key factors of success of an innovative approach, in connection with 3D printing.	Ability to identify an innovative project thanks to 3D printing that will benefit the business/business project of the learner.
Have the knowledge about stages of the Innovation Process with examples of good practices.	Be able to explain the different stages of an innovative project and the relative points of warning.	Ability to be autonomous in the identification of the innovation potential of its own project with 3D printing. Ability to define an innovative project related to 3D printing and meet the conditions that are needed for its success.
Understand the Co-Innovation Concept.	Be able to explain the different stages of an innovative project and the relative points of warning.	Ability to be autonomous in the identification of the innovation potential of its own project with 3D printing. Ability to define an innovative project related to 3D printing and meet the conditions that are needed for its success.

Table 11: Learning Outcomes module 2 - Design thinking & Skills

KNOWLEDGE	SKILLS	COMPETENCES
Know the History of Design Thinking, its definition, and its use in the 3DP.	To gain knowledge about the development of design thinking and to recognise opportunities for applying design thinking as a problem-solving approach and innovation accelerator in production processes by using 3DP.	Linking previous working experience with skills for optimisation and innovation of production processes by using design thinking methods and applying 3DP tools in practice.
Understand the principles of Design Thinking.	Be able to define and explain basic principles of design thinking- the rules that should guide the design process as a tool for innovation of products in traditional craft sectors.	Autonomous ability to use design thinking principles to research and improve the product/process using 3D technology based on the satisfaction of its users. Ability to recognise the many generated ideas and determine which ones are likely to produce specific,

		desired outcomes.
Understand the Design Thinking Process and its stages.	Be able to identify and specify the various stages of the design thinking process and explain the mutual sequences in the design thinking process. Be able to explain the value of the Design Thinking process, its benefits to improve the creative process of product-advantages of using the technology of 3D in this process.	Ability to apply Design Thinking techniques to support the innovation of products/services - to test innovative ideas through a fast iteration cycle. Ability to use Design Thinking mindset in approaching tasks that require "out the box thinking" as a tool to solve complex problems to improve products/processes creatively.
Have knowledge about the Design thinking in relation to the Business Model.	Be able to identify and describe the influence of design thinking on the innovation of traditional business models - generating new business models. Be able to recognise and identify the variety of design thinking business process models, their different approaches to problem-solving and putting product innovations into practice.	Ability to choose a suitable business model of design thinking process for own business/product to innovate them. Autonomous ability to use a suitable business model using 3D printing methodology as a tool for prototyping and innovation of the final product.
Understand the approach of Critical Thinking and its stages.	Be able to identify and describe the critical skills needed for the critical thinking process as a catalyst of changes in design and way for solving problems and innovate products. Be able to identify core methods, tips for improving critical thinking skills used in critical thinking process.	Ability to recognise the most important critical thinking skills, develop them, improve them - their use in product innovation process, to innovate products reflexing the user's needs. The ability to recognise and use the most appropriate method to improve critical skills in order to innovate, improve the product.
Understand the benefits of Design Thinking.	Be able to identify and describe how design thinking benefits an organisation, identify the main benefits of using Design Thinking methods in the production process.	Ability to use and apply design thinking methods as problem-solving methods and innovation accelerators in production processes. Ability to use design thinking to implement culture change within the organisation. Ability to reduce risk of the product, not meeting customer needs, to reduce dependency on individual

		knowledge, hunches, and opinions.
Understand how to adopt Design Thinking methodology with the 3DP for craft and entrepreneurs.	Be able to recognise and explain how 3D printing can contribute to adopting of Design Thinking, the advantages of using 3D printing in product innovation, in prototyping, and product production itself.	Ability to use and apply design thinking methods as a problem-solving methods and innovation accelerator of craft and entrepreneurs production processes by using 3DP.

Table 12: Learning Outcomes module 3 - 3D Printing & Production process

KNOWLEDGE	SKILLS	COMPETENCES
Knowledge about the origin of 3DP.	Expand general knowledge about 3DP.	Ability to relate events from the past to those of the present, thus broadening the general vision of this technology.
Understand the Production Process and available Software.	Be able to identify the different types of Software used in 3D printing.	Ability to determine what kind of program is needed for each step of the 3D printing process, ability to make decisions within the printing process, solve printing problems.
Know about different technologies in 3DP. Knowledge of the various technologies, their advantages and disadvantages, their main applications, and post-processing in each one of them.	Ability to identify what type of technology is needed and used. Be able to identify the different types of technologies. Expand knowledge of the most usable 3D Printing technologies. Go deeper with the current processes, different fields of application for the most usable 3D Printing technologies.	Ability to decide among technologies and be able to predict what the result will be with each technology. Solve printing problems.
Knowledge about different 3DP materials, characteristics of every material.	Describe the most commonly used 3D printing materials, as well as their characteristics. Appreciate the main differences between materials, choosing the appropriate material depending on the final object purpose.	Ability to identify the most suitable material for the process.
Know possible hazards by using the 3DP.	Describe the possible risks, increased awareness of	Ability to evaluate and identify the environment of the 3DP

	potential hazards, and taking action to avoid it.	process for a wide range of risks and dangers.
Understand the Impact of 3DP on the Supply Chain.	Explain the advantages of 3DP impact on the supply chain.	Ability to recognise the possible reduction of the supply chains with the elimination of unnecessary procedures along the process.

Table 13: Learning Outcomes module 4- The current Process, different fields of application

KNOWLEDGE	SKILLS	COMPETENCES
Describe the most commonly used 3D printing technologies and their technical aspects (processes, resolution, accuracy, sizes, security, etc.).	Identify and differentiate the different types of technologies. Identify and interpret the main technical aspects of each technology.	Analyse and differentiate the main 3D printing technologies used. Outlet the main technical aspects of each technology. Ability to decide which technology is the most suitable for printing a 3D model. Be able to identify in advance the result to be obtained with each technology. Be sensitised to solve 3D printing problems in advance.
Describe the extraction of parts and post-treatments applied to different 3D printing technologies.	Outline and understand the extraction process of the main 3D printing technologies. Outline and understand the subsequent treatments of the main 3D printing technologies. Differentiate between the processes of extraction of parts and the subsequent treatments of the main 3D printing technologies.	Be sensitised with the different processes of extraction of parts and subsequent treatments of the main 3D printing technologies. Ability to analyse and understand in detail which technology is most appropriate depending on the final application of the printed model.
Get familiar with the real-life examples in traditional sectors.	To gain in-depth knowledge of the different fields of application of the main 3D printing technologies in traditional sectors. Identify the most appropriate technology depending on the final application.	Outlet the main 3D printing technologies and their processes to apply them in different traditional sectors. Outlet the best technology to manufacture prototypes, moulds, etc. for applications in traditional sectors.
Understand the Environmental Impacts and Reusing Potential.	To gain an in-depth understanding of the environmental impact of the application of 3D printing technologies. Identify possible processes to make this technique greener, such as the use of biodegradable materials.	Recognise the environmental impact of 3D printing technologies and their application for different applications. Demonstrate knowledge about different techniques for making 3D printing greener.

Table 14: Learning Outcomes module 5 - Entrepreneurship and 3D printing, New Business Ideas

KNOWLEDGE	SKILLS	COMPETENCES
Understand the	Be able to identify the	Ability to identify the type of

Entrepreneurship and Entrepreneurs, their types.	different entrepreneurial profiles.	entrepreneur which suits the best to the learner. Be able to work on and analyse the motivations behind an entrepreneurial project.
Understand the development of a business idea with knowing how to start it with the marketing process, financial point, and networking.	To know the key steps that lead to the definition of a successful entrepreneurial project. To get a deep knowledge of the different areas related to an entrepreneurial project: (including management, marketing, finance, network development, etc.) To get the methodology to develop an entrepreneurial project.	Ability to draft a business plan. Ability to analyse the economic sustainability of a business project involving 3D printing. Ability to understand the different challenges related to the set up of an enterprise.
Familiarising with examples of new entrepreneurship ideas using 3DP.	To gain knowledge about different approaches of entrepreneurship in 3D printing and new trends.	Ability to identify potential business opportunities in the 3D printing sector. Be able to identify the key factors that lead to a successful entrepreneurial project involving 3D printing and take inspiration for its project.

Table 15: Learning Outcomes module 6 - Advanced Industrial Robotics applied in crafts

KNOWLEDGE	SKILLS	COMPETENCES
Know the principles of robotics with its history, categories, and basic concept.	Be able to identify the different elements (accessories) that can be attached to robotic applications.	Autonomous ability to determine which accessories are needed in a robotic application. Be capable of identifying which elements of a robotics application could allow them to interact with a specific environment and improve the usefulness of the robot.
Familiarising with accessories for robotics applications.	To gain in depth-knowledge about the creation of software programs to create a robot.	Be capable of creating software programs to command machinery and perform useful automated tasks.

Understand the principles of programming the robot.	To gain in-depth knowledge of the different fields of application of robotics. Identify the most suitable robotic cell and components depending on the final application.	Outlet the main robotic cell and components to apply them in different sectors. Outlet the main application of robotics to optimise production and subsequently, the financial results of an organisation.
Understand the different applications of robotics.	Identify the procedure behind coupling AIR with 3DP. Get familiar with different examples of applications with AIR and 3DP coupled.	Build capacity for generating coupling between AIR and 3D printing. Illustrate different examples of cases that couple AIR with 3DP.
Know principles of Coupling Air with 3DP with examples.	Be able to identify the different elements (accessories) that can be attached to robotic applications.	Autonomous ability to determine which accessories are needed in a robotic application. Be capable of identifying which elements of a robotics application could allow them to interact with a specific environment and improve the robot's usefulness.

8 TRAINING GROUPS

As defined in the project proposal, based on the results obtained in O1, the Joint Curriculum output will analyse and define training paths, which best match the profile of different target groups. The training path is there, so design so that all the needs, 3D Printing skills, and transversal capacities identified in O1 are appropriately addressed.

The ACCESS-3DP will impact the three target groups in the following way:

- The **first target group** consists of individuals with an affinity towards the relevant sectors covered within the project. They already have a basic understanding of the broader topics, which the complete training covers as these are professionals of technologies, such as (1) Designers, (2) 3D printing manufacturers, (3) those interested in moving into these sectors and (4) Entrepreneurs who want to set up a creative business in the traditional sectors or the new additive manufacturing and 3D printing technologies. Therefore, the objective of the tailored training module is to relaunch the traditional sectors, promote creativity, innovation, and competitiveness, and get highly skilled workers., without burdening them with basic LOs that are intended to explain the fields they have practical experience in (e.g. What is thinking?). Their training path is focused on the practical aspects provided (e.g. Real life example).

- The **second target group** consists of students, including VET providers on manufacturing in traditional sectors or new technologies, Universities on CAD Design and 3D printing technology, unemployed and other students interested in industrial CAD design, manufacturing processes in 3D printing, and craft industries. As this group includes people that may have no previous knowledge of any of the topics covered in the training path, they are offered the full spectrum of LOs. This approach ensures that the target group will understand the basics of running a business, innovation etc., before learning specific knowledge connected to the 3DP and AM.

- The **third and final target group** is very mixed and involves "Other Relevant Stakeholders" that vary from educational authorities, support environment to decision-makers. The purpose of training for this target group is different from the first two, as in this case, it is not expected they will apply the knowledge gained in the practical fields. However, in the scope of their work, they can contribute to the sector's development, but only if they possess enough understanding of it. Therefore, the main objective of training this target group is the dissemination of knowledge and awareness-raising and general advancement of 3DP and AM.

The ACCESS-3DP Consortium also recognised the need to personalise the training path according to the needs of the participants, who want to learn and know more about specific topics only. Those participants can express their knowledge needs in particular learning objects in their interest without going through the whole training path. This need is satisfied with the **open-access course**, but with the difference not to achieve final certification for completing the course. Additionally, Consortium prepared the short Questionnaire for participants to help them to identify which topics to address. The Questionnaire will be available inside the online learning platform after participants choose this kind of learning path.

Table 16: Questionnaire for open-access course

Question	YES	NO
Do you know about innovation process means and its different stages?	LO3. Innovation Management and New Product Development LO4. Co-innovation concept	All module 1
Are you familiar with Design Thinking Process and its different steps?	LO8 – Design Thinking and Business models (name change) LO10 – Benefits of design thinking LO11 – 3DP as A tool to adopt the design thinking methodology for craft entrepreneur	All module 2
Do you already have some competences on 3D printing and its production process (design software, technologies, etc.)?	LO15 – 3D printing materials LO16 – Risk Management LO17 – Impact of 3D printing on the supply chain	All module 3
Do you know the different 3DP technologies characteristics (resolution, accuracy, sizes, security, etc.)?	LO20. 3DP technologies. Real-life examples in traditional sectors LO21. 3DP technologies. Real-life examples in non-traditional sectors LO22. Environmental impact and reusing potential	All module 4
Have you ever set up a business in any sector?	LO24 - Generating and Developing a Business Idea, 3D Printing Business Ideas LO25 - New Entrepreneurship ideas using 3D printing	All module 5
Are you familiar with industrial robotics?	LO28 – Criteria for the implementation of a robot LO29 - Application of robotics LO30 - Coupling AIR with 3D printing. Theory and real examples	All module 6

8.1. GENERAL OVERVIEW

30/30 LOs 250/250 LHs 15/15 ECVT

MODULE 1 → Innovation process applied to traditional sector Design and 3DP	MODULE 2 → Design Thinking & Skills	MODULE 3 → 3D Printing & Production Process	MODULE 4 → Current processes - Different fields of application	MODULE 5 → Entrepreneurship and 3D Printing - New business Ideas	MODULE 6 → Advanced Industrial Robotics applied in crafts
LO1. Basic of Innovation process	LO5. What is Design Thinking?	LO12. History of 3D Printing	LO18. 3DP Technologies → Processes, Resolution, Accuracy, Sizes, Security	LO23. What is Entrepreneurship?	LO26. Principles and fundamentals of robotics.
LO2. Stages of Innovation Process	LO6. Principles of Design Thinking	LO13. Description of the Production Processes and Avaliable Software for 3D printing	LO19. 3DP Technologies → Extract the pieces, post-processes	LO24. Generating and Developing a Business Idea, 3D Printing Business Ideas	LO27. Programming a robot
LO3. Innovation Management and New Product Development	LO7. Design Thinking process	LO14. Technologies in 3D Printing	LO20. 3DP Technologies → Real-life examples – TRADITIONAL sectors / field of application - furniture, shoes and other sectors	LO25. New Entrepreneurship ideas using 3D printing	LO28. Criteria for the implementation of a robot
LO4. Co-innovation concept	LO8. Design thinking business model	LO15. 3D Printing Materials	LO21. 3DP Technologies → Real-life examples – NON-TRADITIONAL (MODERN) sectors / field of application - creative industry		LO29. Applications of robotics
	LO9. Critical Thinking Skills	LO16. Risk Managment	LO22. Enviromental Impact and Reusing Potential		LO30. Coupling AIR with 3DP. Theory and real examples
	LO10. Benefits of Design Thinking	LO17. Impact of 3D printing on the supply chain			
	LO11. 3DP as a tool to adopt the design thinking methodology for craft and entrepreneur.				

8.2. PROFESSIONALS, WORKERS, ENTREPRENEURS

22/30 LOs 193/250 LHs 11,52/15 ECVT

MODULE 1 → Innovation process applied in traditional sector: Design and 3DP	MODULE 2 → Design Thinking & Skills	MODULE 3 → 3D Printing & Production Process	MODULE 4 → Current processes - Different fields of application	MODULE 5 → Entrepreneurship and 3D Printing - New business Ideas	MODULE 6 → Advanced Industrial Robotics applied in crafts
LO1. Basic of Innovation process	LO5. What is Design Thinking?	LO12. History of 3D Printing	LO18. 3DP Technologies → Processes, Resolution, Accuracy, Sizes, Security	LO23. What is Entrepreneurship?	LO26. Principles and fundamentals of robotics.
LO2. Stages of Innovation Process	LO6. Principles of Design Thinking	LO13. Description of the Production Processes and Avaliable Software for 3D printing	LO19. 3DP Technologies → Extract the pieces, post-processes	LO24. Generating and Developing a Business Idea, 3D Printing Business Ideas	LO27. Programming a robot
LO3. Innovation Management and New Product Development	LO7. Design Thinking process	LO14. Technologies in 3D Printing	LO20. 3DP Technologies → Real-life examples – TRADITIONAL sectors / field of application - furniture, shoes and other sectors	LO25. New Entrepreneurship ideas using 3D printing	LO28. Criteria for the implementation of a robot
LO4. Co-innovation concept	LO8. Design thinking business model	LO15. 3D Printing Materials	LO21. 3DP Technologies → Real-life examples – NON-TRADITIONAL (MODERN) sectors / field of application - creative industry		LO29. Applications of robotics
	LO9. Critical Thinking Skills	LO16. Risk Managment	LO22. Enviromental Impact and Reusing Potential		LO30. Coupling AIR with 3DP. Theory and real examples
	LO10. Benefits of Design Thinking	LO17. Impact of 3D printing on the supply chain			
	LO11. 3DP as a tool to adopt the design thinking methodology for craft and entrepreneur.				

8.3. STUDENTS, VET PROVIDERS, UNIVERSITIES, UNEMPLOYED

30/30 LOs 250/250 LHs 15/15 ECVT

MODULE 1 → Innovation process applied in traditional sector - Design and 3DP	MODULE 2 → Design Thinking & Skills	MODULE 3 → 3D Printing & Production Process	MODULE 4 → Current processes - Different fields of application	MODULE 5 → Entrepreneurship and 3D Printing - New business Ideas	MODULE 6 → Advanced Industrial Robotics applied in crafts
LO1. Basic of Innovation process	LO5. What is Design Thinking?	LO12. History of 3D Printing	LO18. 3DP Technologies → Processes, Resolution, Accuracy, Sizes, Security	LO23. What is Entrepreneurship?	LO26. Principles and fundamentals of robotics.
LO2. Stages of Innovation Process	LO6. Principles of Design Thinking	LO13. Description of the Production Processes and Avaliable Software for 3D printing	LO19. 3DP Technologies → Extract the pieces, post-processes	LO24. Generating and Developing a Business Idea, 3D Printing Business Ideas	LO27. Programming a robot
LO3. Innovation Management and New Product Development	LO7. Design Thinking process	LO14. Technologies in 3D Printing	LO20. 3DP Technologies → Real-life examples – TRADITIONAL sectors / field of application - furniture, shoes and other sectors	LO25. New Entrepreneurship ideas using 3D printing	LO28. Criteria for the implementation of a robot
LO4. Co-innovation concept	LO8. Design thinking business model	LO15. 3D Printing Materials	LO21. 3DP Technologies → Real-life examples – NON-TRADITIONAL (MODERN) sectors / field of application - creative industry		LO29. Applications of robotics
	LO9. Critical Thinking Skills	LO16. Risk Managment	LO22. Enviromental Impact and Reusing Potential		LO30. Coupling AIR with 3DP. Theory and real examples
	LO10. Benefits of Design Thinking	LO17. Impact of 3D printing on the supply chain			
	LO11. 3DP as a tool to adopt the design thinking methodology for craft and entrepreneur.				

8.4. OTHER RELEVANT STAKEHOLDERS FROM TRADITIONAL SECTORS, LOCAL EDUCATION AUTHORITIES, POLICY-MAKERS

17/30 LOs 150/250 LHs 9/15 ECVT

MODULE 1 → Innovation process applied in traditional sector - Design and 3DP	MODULE 2 → Design Thinking & Skills	MODULE 3 → 3D Printing & Production Process	MODULE 4 → Current processes - Different fields of application	MODULE 5 → Entrepreneurship and 3D Printing - New business Ideas	MODULE 6 → Advanced Industrial Robotics applied in crafts
LO1. Basic of Innovation process	LO5. What is Design Thinking?	LO12. History of 3D Printing	LO18. 3DP Technologies → Processes, Resolution, Accuracy, Sizes, Security	LO23. What is Entrepreneurship?	LO26. Principles and fundamentals of robotics.
LO2. Stages of Innovation Process	LO6. Principles of Design Thinking	LO13. Description of the Production Processes and Avaliable Software for 3D printing	LO19. 3DP Technologies → Extract the pieces, post-processes	LO24. Generating and Developing a Business Idea, 3D Printing Business Ideas	LO27. Programming a robot
LO3. Innovation Management and New Product Development	LO7. Design Thinking process	LO14. Technologies in 3D Printing	LO20. 3DP Technologies → Real-life examples – TRADITIONAL sectors / field of application - furniture, shoes and other sectors	LO25. New Entrepreneurship ideas using 3D printing	LO28. Criteria for the implementation of a robot
LO4. Co-innovation concept	LO8. Design thinking business model	LO15. 3D Printing Materials	LO21. 3DP Technologies → Real-life examples – NON-TRADITIONAL (MODERN) sectors / field of application - creative industry		LO29. Applications of robotics
	LO9. Critical Thinking Skills	LO16. Risk Managment	LO22. Enviromental Impact and Reusing Potential		LO30. Coupling AIR with 3DP. Theory and real examples
	LO10. Benefits of Design Thinking	LO17. Impact of 3D printing on the supply chain			
	LO11. 3DP as a tool to adopt the design thinking methodology for craft and entrepreneur.				

9. TRAINING PATH DEFINITION

9.1. ACCESS-3DP TRAINING STRUCTURE

MODULE 1: Innovation process applied in traditional sector - Design and 3DP

Table 17: Description of Module 1

TRAINING UNIT	OBJECTIVE	LEARNING OUTCOME	PEDAGOGICAL APPROACH	ASSESSMENT METHODOLOGY
1.1. Basics of Innovation process	Introduction to concepts of Innovation process	**Knowledge:** Have knowledge of Innovation concepts **Skills:** Recognize different types of innovation with key factors of success **Competences:** Ability to identify an innovation 3D project	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
1.2. Stages of Innovation process	Describing the stages of the innovation process with good practices examples	**Knowledge:** Have knowledge about stages of innovation process **Skills:** Describe different stages in innovation project **Competences:** Ability to identify innovation potential	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
1.3. Innovation Management and New Product	Introduction to management in the innovation project and	**Knowledge:** Have knowledge about management in innovative	PowerPoint Text	Assessing and validating the acquired learning outcomes

Development	describing new product development	3D printing project **Skills:** Defining the management principles **Competences:** Ability to manage the innovative 3D printing project		
1.4. Co- innovation Concept	Description of Co-Innovation Concept with different stages of an innovative project	**Knowledge:** Know the co-innovation concept **Skills:** Defining the concept of co-innovation **Competences:** Ability to work in a co-innovation environment	PowerPoint Text	Assessing and validating the acquired learning outcomes

MODULE 2: Design Thinking & Skills

Table 18: Description of Module 2

TRAINING UNIT	OBJECTIVE	LEARNING OUTCOME	PEDAGOGICAL APPROACH	ASSESSMENT METHODOLOGY
2.1. What is Design Thinking?	Introduction to Design Thinking with its history, theory and practical use	**Knowledge:** Know the History of Design Thinking, its definition and its use in 3DP and its development **Skills:** Recognise opportunities to use Design Thinking in practice **Competences:** Autonomous ability to use design thinking methods	PowerPoint Text Video	Assessing and validating the acquired learning outcomes

		for optimization and innovative approach in the production process		
2.2. Principles of Design Thinking	Describing the basic principles in Design Thinking	**Knowledge:** Understand the principles of Design Thinking **Skills:** Be able to define and explain basic principles for guidance in the design innovation process **Competences:** Ability to use design thinking principles for research and improving the 3D process with recognition of ideas with a specific desired outcome	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
2.3. Design Thinking process	Describing the Design Thinking Process and its stages	**Knowledge:** understand the Design Thinking Process and its stages **Skills:** Be able to identify and specify the various stages of the design thinking process **Competences:** Ability to apply Design Thinking techniques to support innovation and as a tool to solve problems to improve products creativity	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
2.4. Design Thinking and	Describing Design Thinking	**Knowledge:** have	PowerPoint	Assessing and validating

business models	function in generating innovation in the business models	knowledge about the Design Thinking Process and its stages **Skills:** Be able to identify and describe the influence of Design Thinking on the innovation of traditional business models and be able to recognize and identify the variety of business process models **Competences:** Ability to choose a suitable business model for an innovative product or process.	Text Video	the acquired learning outcomes
2.5. Critical Thinking Skills	Introduction to skill-set in the process of Critical Thinking	**Knowledge:** know about skills required for critical thinking process, understand its stages and overall approach **Skills:** Be able to identify and describe the skills needed to solve problems and innovate products **Competences:** Ability to recognize the most important critical thinking skills with development by developing and improving them	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
2.6. Benefits of Design	Describing the benefits of	**Knowledge:** methodology	PowerPoint	Assessing and validating

Thinking	Design Thinking for an organisation with methods in the production process	with the 3DP **Skills:** be able to recognize and explain how Design Thinking can accelerate the 3DP in product innovation **Competences:** Ability to use and apply design thinking methods as a problem-solving methods and innovation accelerator	Text Video	the acquired learning outcomes
2.7. 3DP as a tool to adopt the Design Thinking methodology for craft and entrepreneur	Introduction how to adopt Design Thinking methodology with the 3DP	**Knowledge:** understand how to adopt Design Thinking methodology with the 3DP for craft abd entrepreneurs **Skills:** be able to recognize and explain how 3DP can contribute to adopting of Design Thinking **Competences:** Ability to use and apply design thinking methods as a problem-solving methods and innovation accelerator	PowerPoint Text Video	Assessing and validating the acquired learning outcomes

Table 9: Description of Module 3

MODULE 3: 3D Printing & Production Process

Table 19: Description of Module 3

TRAINING UNIT	OBJECTIVE	LEARNING OUTCOME	PEDAGOGICAL APPROACH	ASSESSMENT METHODOLOGY
3.1. History of 3D Printing	Describing the history of 3DP	**Knowledge:** knowledge about the origin of 3DP **Skills:** expend general knowledge about 3DP **Competences:** ability to relate events from to the present and broadening the general vision of this technology	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
3.2. Description of the Production Process and available Software	Describing the Production Process and available Software with the different types	**Knowledge:** understand the production process and available software **Skills:** be able to identify the different types of Software used in 3D printing **Competences:** ability to determine what kind of program is needed for each step of the 3D printing process, ability to make decisions within the printing process, solve printing problems	PowerPoint	Assessing and validating the acquired learning outcomes

3.3. Technologies in 3D Printing	Description of different technologies with advantages and disadvantages, their main application	**Knowledge:** know about different technologies in 3DP with advantages and disadvantages and post-processing **Skills:** be able to identify the different types of technologies with different fields of application **Competences:** ability to decide among technologies and be able to predict results. Solving printing process problems	Text	Assessing and validating the acquired learning outcomes
3.4. 3D Printing Materials	Describing different 3DP materials, their differences and choosing the right one for the process	**Knowledge:** know about different 3DP materials, characteristics of every material **Skills:** describe 3DP materials , choosing the appropriate materials depending on the final object purpose **Competences:** ability to identify the most suitable material for the process	Text	Assessing and validating the acquired learning outcomes
3.5. Risk Management	Describing possible risks in 3DP	**Knowledge:** know possible hazards in 3DP **Skills:** describe the possible risks with awareness rising about hazards and avoiding	Text	Assessing and validating the acquired learning outcomes

		them **Competences:** ability to evaluate and identify the environment for the wide range of risks and dangers		
3.6. Impact of 3D Printing on the supply chain	Describe the impact and advantages of 3DP on the Supply Chain	**Knowledge:** understand the impact of 3DP on the supply chain **Skills:** explain the advantages of 3DP impact on supply chain **Competences:** ability to recognize the possible reduction of the supply chains with the elimination of unnecessary producers along the process	Text	Assessing and validating the acquired learning outcomes

MODULE 4: Current processes - Different fields of application

Table 20: Description of Module 4

TRAINING UNIT	OBJECTIVE	LEARNING OUTCOME	PEDAGOGICAL APPROACH	ASSESMENT METHODOLOGY
4.1. 3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security	Describing the most used 3D printing technologies along with their technical aspects	**Knowledge:** know about the most commonly used 3D printing technologies and their technical aspects (processes, resolution, accuracy,..)	PowerPoint Video	Assessing and validating the acquired learning outcomes

		Skills: identify and differentiate the types of technologies **Competences:** ability to decide which technology is the most suitable for 3DP, identifying the obtain result within each technology along with problem solving knowledge		
4.2. 3DP Technologies- Extract the pieces, post-processes	Describing the extraction of parts and post-treatments applied to different 3DP technologies	**Knowledge:** know about post-processing and piese extractions of the parts **Skills:** know difference between processes of extraction and understanding the subsequent treatments of 3D technologies **Competences:** Be sensitised with the different processes of extraction of parts and subsequent treatments. Ability to analyse and understand in detail which technology is most appropriate	PowerPoint Video	Assessing and validating the acquired learning outcomes
4.3. 3DP Technologies- Real life examples - TRADITIONAL sectors/field	Describing the real-life examples in traditional sector	**Knowledge:** know about real-life examples in traditional sectors and different fields of	PowerPoint Text	Assessing and validating the acquired learning outcomes

		application of the main 3D printing technologies in traditional sectors **Skills:** be able to identify the most suitable technology depending on the final application. **Competences:** ability to apply main 3DP technologies in different traditional sectors with analysing and understand, which is the most appropriate to use		
4.4. 3DP Technologies- Real life examples- NON TRADITIONAL modern sectors	Describing the real-life examples in non-traditional sector	**Knowledge:** know about real-life examples in non-traditional sectors and different fields of application of the main 3D printing technologies in traditional sectors **Skills:** be able to identify the most suitable technology depending on the final application. **Competences:** ability to apply main 3DP technologies in different non-traditional sectors with analysing and understand, which is the most	PowerPoint Text	Assessing and validating the acquired learning outcomes

		appropriate to use		
4.5. Environmental impact and Reusing Potential	Introduction to the environmental aspect and reusing potential in 3DP	**Knowledge:** Understand the Environmental Impacts and Reusing Potential **Skills:** be able to identify the possible use of biodegradable materials in the process and possible eco-friendly techniques **Competences:** Recognise the environmental impact of 3D printing technologies and their application for different applications. Demonstrate knowledge about different techniques for making 3D printing greener.	PowerPoint Text	Assessing and validating the acquired learning outcomes

MODULE 5: Entrepreneurship and 3D Printing - New Business Ideas

Table 21: Description of Module 5

TRAINING UNIT	OBJECTIVE	LEARNING OUTCOME	PEDAGOGICAL APPROACH	ASSESMENT METHODOLOGY
5.1. What is Entrepreneurship?	Introduction to the entrepreneurship	**Knowledge:** Understand the principles of Entrepreneurship and its types **Skills:** Be able to identify	PowerPoint Text Video	Assessing and validating the acquired learning outcomes

		the different entrepreneurial profiles **Competences:** Ability to determine the type of entrepreneurs		
5.2. Generating and Developing Business ideas 3D Printing Business ideas	Introduction to the development of a business 3DP idea	**Knowledge:** Understand the development of a business idea with knowing how to start it with the marketing process, financial point, and networking **Skills:** to know the key steps that lead to the definition of a successful entrepreneurial project **Competences:** Ability to draft a business plan and analyse the economic sustainability of a business 3DP project	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
5.3. New Entrepreneurship ideas using 3D Printing	Introduction to the examples of entrepreneurship ideas in 3DP	**Knowledge:** Familiarizing with examples of new entrepreneurship ideas using 3DP **Skills:** to gain knowledge about different approaches of entrepreneurship in 3D printing and new trend **Competences:** Ability to identify potential business	Text Video	Assessing and validating the acquired learning outcomes

		opportunities in the 3D printing sector Be able to identify the key factors that lead to a successful entrepreneurial project involving 3D printing and take inspiration for its project		

MODULE 6: Advanced Industrial Robotics applied in crafts

Table 22: Description of Module 6

TRAINING UNIT	OBJECTIVE	LEARNING OUTCOME	PEDAGOGICAL APPROACH	ASSESMENT METHODOLOGY
6.1. Advanced Industrial Robotics applied in crafts	Introduction to the principles of robotics	**Knowledge:** Know the principles of robotics with its history, categories, and	PowerPoint Text	Assessing and validating the acquired learning outcomes

		basic concept **Skills:** Be able to identify the different elements (accessories) attached to robotic applications **Competences:** Autonomous ability to determine which accessories are needed in a robotic application. Be capable of idenitify which elements of a robotics application could allow them to interact with a specific environment and improve the usefulness of the robot.		
6.2. Programming a robot	Introduction to robot's programming	**Knowledge:** Familiarizing with accessories for robotics applications **Skills:** To gain in-depth knowledge about the creation of software programs to create a robot **Competences:** Be capable of creating software programmes to command machinery and perform useful automated tasks	PowerPoint Text	Assessing and validating the acquired learning outcomes
6.3. Criteria for the implementation of a robot	Describing the process of robot's implementation	**Knowledge:** Familiarizing with accessories for robotics applications	PowerPoint Text	Assessing and validating the acquired learning outcomes

		Skills: To gain in-depth knowledge about the creation of software programs to create a robot **Competences:** Be capable of creating software programmes to command machinery and perform useful automated tasks		
6.4. Applications of robots	Describing the different robot's applications	**Knowledge:** Understand the different applications of robotics **Skills:** Identify the procedure behind coupling AIR with 3DP. Get familiar with different examples of applications with AIR and 3DP coupled **Competences:** Build capacity for generating coupling between AIR and 3D printing. Illustrate different examples of cases that couple AIR with 3DP	PowerPoint Text Video	Assessing and validating the acquired learning outcomes
6.5. Coupling AIR with 3D, Theory and real examples	Introduction to Advanced Industrial Robotics with 3DP and presentation of real examples	**Knowledge:** Know principles of Coupling Air with 3DP with examples **Skills:** Be able to identify the different elements (accessories) that can be attached to robotic	PowerPoint Text Video	Assessing and validating the acquired learning outcomes

		applications **Competences:** Autonomous ability to determine which accessories are needed in a robotic application. Be capable of identifying which elements of a robotics application could allow them to interact with a specific environment and improve the robot's usefulness.		

10. ACCESS-3DP ECVET POINTS

For the ECVET framework implementation, qualifications need to be described in learning outcomes with associated points. These are also called Credit or ECVET points.[1] They are defined as *a numerical representation of the overall weight of learning outcomes in a qualification and the relative weight of units related to the qualification*. Their allocation to all learning units is needed to prepare the learning material due to verification with other qualifications like national legislation and overall learning outcomes.

The amount of ECVET points allocated to a learning unit depends on two factors. First is the time, which is needed to acquire the learning outcomes in the specific unit. Second is the relevance of the learning outcomes within the particular unit. Based on the assumptions of the ECVET Secretariat and several national authorities, ECVET credits are assigned on a system of **1 ECVET = 1 ECTS = 25 hours** of total learning. Non-formal and informal learning are included in this calculation. There is no actual calculation or criteria to define the time spent studying, self-studying, contacting, doing practical exercises, and self-assessment. With the course validation, the assurance to achieve efficient results is performed.

Figure 1: Assignment of ECVET points

[1] 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) (OJ C 155, 8.7.2009, pp. 11-18)

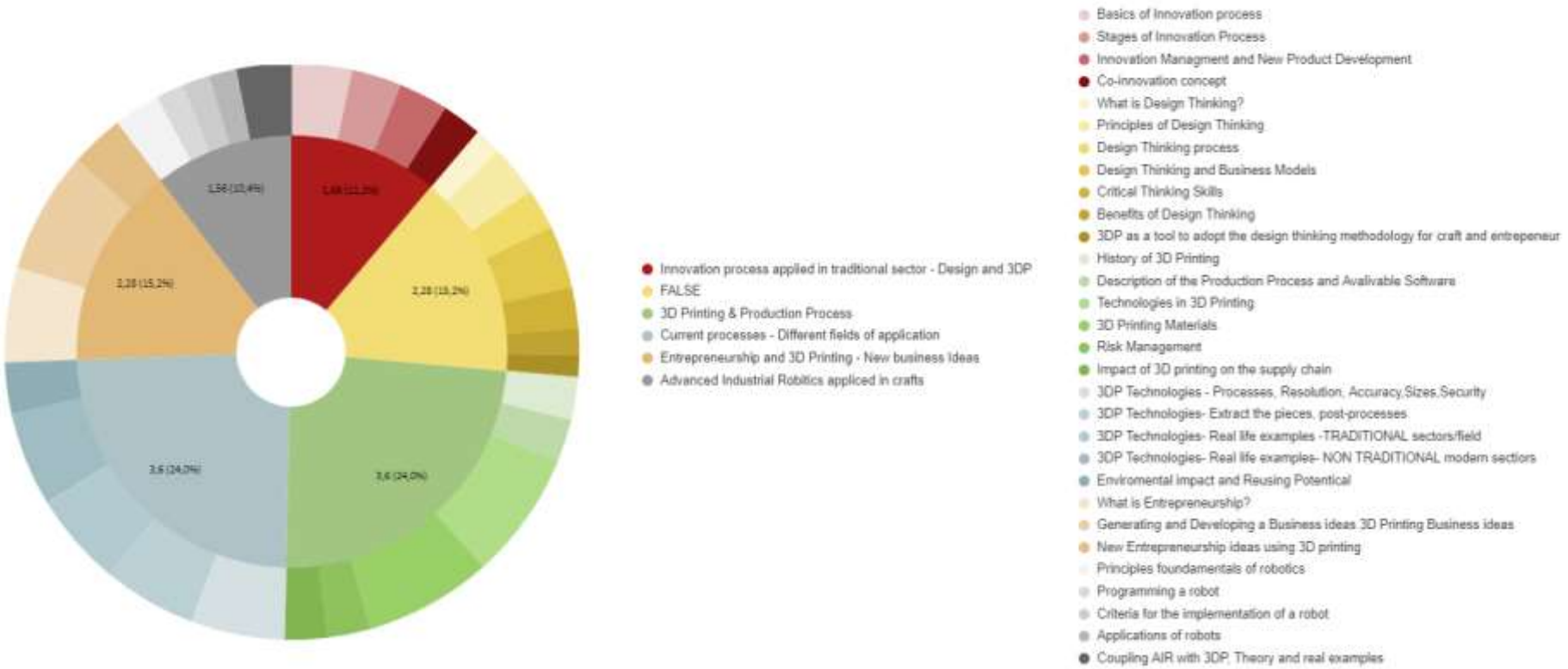
The following tables showcase an attempt to estimate ECVET points for each ACCESS-3DP training module and learning object, based on time, relevance and weight.

Table 23: ECVET points ACCESS-3DP

M#	Module Name	M hours	M weight	M ECVET	Learning Object description	LO hours	LO weight	LO ECVET
1	Innovation process applied in traditional sector - Design and 3DP	28	11,20%	1,68	Basics of Innovation process	8,40	30,0%	0,50
					Stages of Innovation Process	7,00	25,0%	0,42
					Innovation Management and New Product Development	7,00	25,0%	0,42
					Co-innovation concept	5,60	20,0%	0,34
2	Design Thinking & Skills	38	15,20%	2,28	What is Design Thinking?	3,80	10,0%	0,23
					Principles of Design Thinking	7,22	19,0%	0,43
					Design Thinking process	5,70	15,0%	0,34
					Design Thinking and Business Models	8,74	23,0%	0,52
					Critical Thinking Skills	5,70	15,0%	0,34
					Benefits of Design Thinking	3,80	10,0%	0,23
					3DP as a tool to adopt the design thinking methodology for craft and entrepreneur	3,04	8%	0,18
3	3D Printing & Production Process	60	24,00%	3,6	History of 3D Printing	6,00	10,0%	0,36
					Description of the Production Process and Available Software	6,00	10,0%	0,36
					Technologies in 3D Printing	18,00	30,0%	1,08
					3D Printing Materials	18,00	30,0%	1,08
					Risk Management	6,00	10,0%	0,36
					Impact of 3D printing on the supply chain	6,00	10,0%	0,36
4	Current processes - Different fields of application	60	24,00%	3,6	3DP Technologies - Processes, Resolution, Accuracy, Sizes, Security	13,20	22,0%	0,79

					3DP Technologies- Extract the pieces, post-processes	13,20	22,0%	0,79
					3DP Technologies- Real life examples - TRADITIONAL sectors/field	13,20	22,0%	0,79
					3DP Technologies- Real life examples- NON TRADITIONAL modern sectors	13,20	22,0%	0,79
					Environmental impact and Reusing Potential	7,20	12,0%	0,43
5	Entrepreneurship and 3D Printing - New business Ideas	38	15,20%	2,28	What is Entrepreneurship?	13,30	35,0%	0,80
					Generating and Developing a Business ideas 3D Printing Business ideas	17,10	45,0%	1,03
					New Entrepreneurship ideas using 3D printing	7,60	20,0%	0,46
6	Advanced Industrial Robotics applied in crafts	26	10,40%	1,56	Principles fundamentals of robotics	6,50	25,0%	0,39
					Programming a robot	3,90	15,0%	0,23
					Criteria for the implementation of a robot	3,90	15,0%	0,23
					Applications of robots	3,90	15,0%	0,23
					Coupling AIR with 3DP, Theory and real examples	7,80	30,0%	0,47

Figure 2: ECVET points distribution among Modules



11. JOINT CURRICULUM VALIDATION

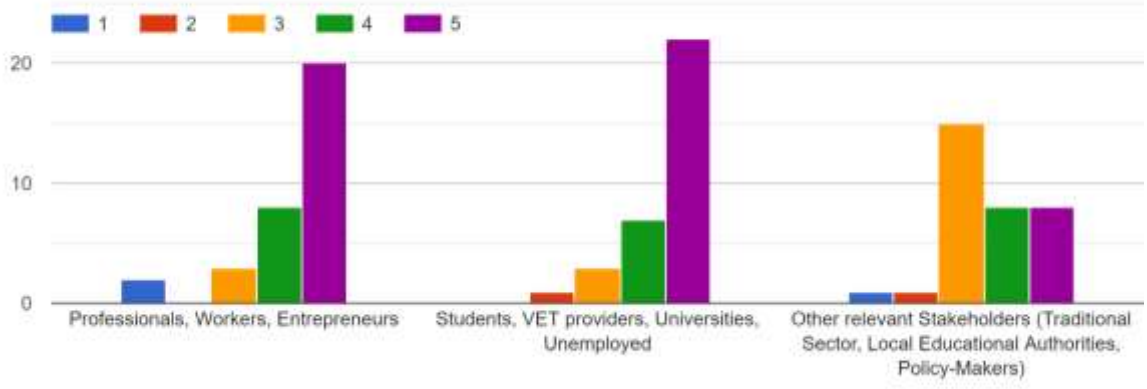
Partners identified general assessment questions and each module and learning object assessment questions to evaluate and validate and identify potential weaknesses and opportunities for improvement of the Joint Curriculum. The evaluation and validation questions were disseminated among the stakeholders with the Google form Questionnaire. Each project partner was requested to identify at least six stakeholders. They represented different organisations, companies and universities. Altogether, we received 33 replies from 8 countries (Annex III). Each stakeholder received an interactive Joint Curriculum presentation and the PDF Joint Curriculum Overview (Annex I). Both were translated into partners' languages.

The questions ranged from the general ones (name of organisation, position, country) and overall assessing of the JC, to the more specific ones about the necessity of Modules and Learning Objects. The sample of the Questionnaire is available in Annex II.

In general, the replies showed overall satisfaction with the presented Joint Curriculum. The feedback is summarised as follows:

1. The ACCESS-3DP course target three main target groups: (1) Professionals, Workers, Designers, Entrepreneurs, (2) Students, VET providers, Universities, Unemployed, and (3) Other relevant Stakeholders (Traditional Sectors, Local Educational Authorities, Policy-Makers). Please rank with marks from 1 to 5 (with five being the highest) the necessity for each of these defined training paths:

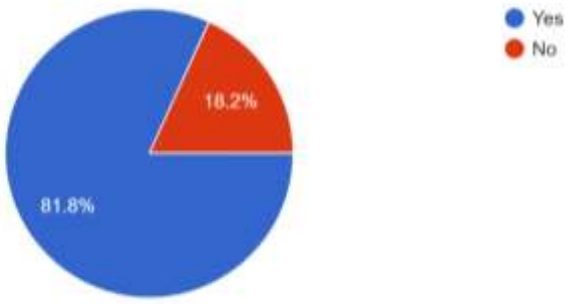
Table 24: Level of necessity per Training groups



Stakeholders have ranked highly the necessity of a training path adapted for Students, VET providers, Universities and the Unemployed. Also, the great need of a training path was shown for the Professionals, Workers and Entrepreneurs. Still, less with the Other relevant Stakeholders, which can be explained by the fact that most of the contacted stakeholders were from SMEs and universities. They do not recognize the potential of knowledge gained about 3D printing in their sector so much.

2. Each of the previous target groups will have a different training path suggested for them and, after its successful completion, they will receive a certificate of the course. Do you consider it necessary to receive this certificate?

Table 25: Level of the necessity of certificate after course completion



When asked whether the Certificate should be received at the end of the course, almost 82 % of respondents think it should be issued upon completion.

3. If not, please explain your answer:

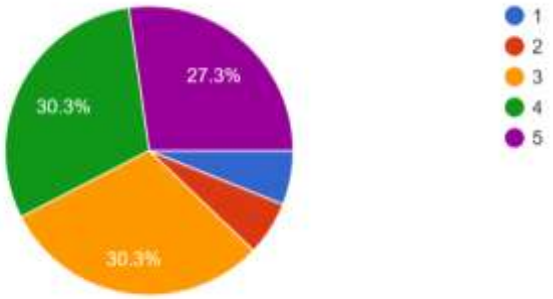
Some of the comments show that certificates should be dedicated only to the students since they could be important for their job search. The certificate also isn't showing the actual knowledge and skills on the field in some opinion and should be issued by an official body only. The full overview of the received comments is available below.

Table 26: Comments related to the Certificate after completion

I consider certification to be relevant if and only if it is issued by an official body.
The certificate is very important for the target students and not necessary for others.
The acquisition of knowledge and skills is more important than the certificate which says nothing about what one really knows how to do with the training one has taken.
Only for the students' target.
Chaos in a number of certificates, expertise is in one's own education and is supposed to be the immanence of education.
The certificate does not bring knowledge and skills, it is only important if the course is recognized, after the first editions of the course being successful. But, at the same time, I believe that there is no problem if those participants get the certificate.

4. Apart from the specific training path for the different target groups, there will be a training path opened to all users interested in gaining the knowledge and skills they are looking for, but without receiving certification in the end. Please rank with marks from 1 to 5 (with 5 being the highest) the necessity of this defined "Open-access course - without certification":

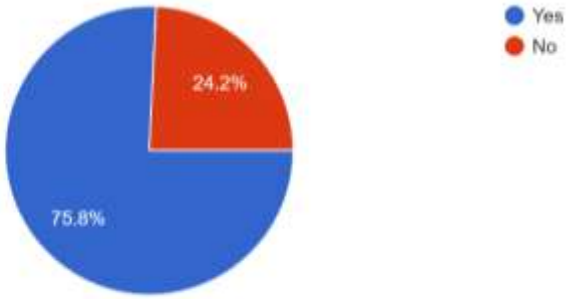
Table 27: Level of the necessity of open-access course



A vast majority of stakeholders agree with the open-access course – without certification.

5. Do you agree that students for this open-access course don't receive the certificate?

Table 28: Level of agreement with not receiving certificate within the open-access course



When asked whether the Certificate will not be received by the end of the open-access course, almost 76% of respondents agree.

6. If not, please explain your answer:

Some of the comments show that a certificate should be given in any way. Some of the comments could be explained in a way that stakeholders misunderstand the question and thought, that students (not participants) will not receive a certificate at all. The full overview of the received comments is available below.

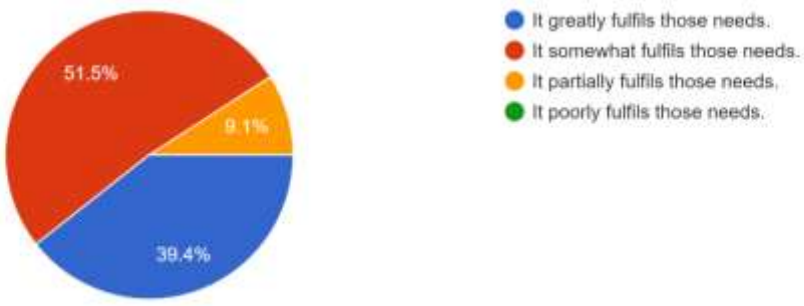
Table 29: Comments about the Certificate not given by the end of the open-access course completion

Because the certificate is one document that they can spend in their carrier life.
The certificate is a motivation even for non-payers. Especially students could inhibit joining

due to a price. But if the price is not so high, it sounds to me like a good solution to offer everybody the knowledge.
If they have done the course, they are also have to get the certificate in a way.
If the learner is a student, it's important to propose him a certificate.
Because the participation would be without motivation.
The certificate is the document that the employers need to see to prove that a possible candidate for a job has done the training or to impute the obligatory training hours to their employees.
I would determine the key parts / topics of the course (in the range of about 75% of all topics), which if the participant completes the certificate will receive.
Open access should not discriminate against its candidates.
After complete completion of all theoretical and practical parts of the course, participants would receive a certificate.

7. In your opinion do you think the Joint Curriculum properly addresses the needs of the target groups to enhance the knowledge, skills, and competencies in 3D Printing?

Table 30: Level of agreement related to fulfilment of target group needs by the Joint Curriculum



The overall opinion shows stakeholders agree with the fulfilment of needs for target groups. None said that the Joint Curriculum poorly fulfils them.

8. Please, explain your answer:

Stakeholders were asked to explain their answers. Comments are referred to need to present real examples on the shop-floor with the machine work, more technical topics inclusion, and possible lack of preliminary skills in CAD programming. All of these comments will be taken into consideration when developing the ACCESS-3DP training materials. However, it is important to notice that most generally had positive comments about the Joint Curriculum. The complete overview of the received comments is available below.

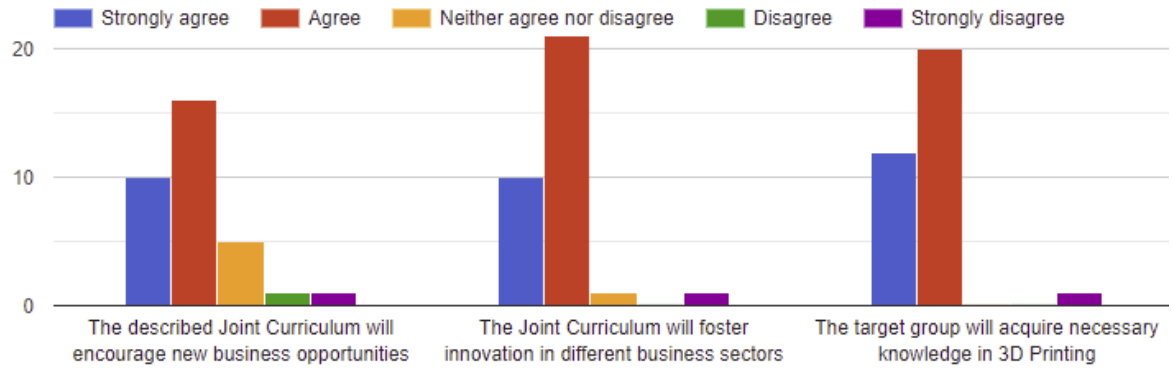
Table 31: Comments related to the fulfilment of the target group needs by the Joint Curriculum

I find the syllabus very complete but looking at the JC I don't understand/see the difference between the three itineraries.
The course fulfils a considerable range of uses of 3D printing, from its motivation as an innovative technological solution, to its potential to foster creative methodologies or to support different activities within the labour framework, such as maintenance activities.

All basic knowledge is covered, I recommend to present real examples from the shop-floor.
3D printing is a reality but it has not reached all sectors, especially the traditional ones. On the one hand, they do not know how to use them at a technical level, but they are also unclear about how to undertake or take advantage of them.
It is well balanced, also providing transversal skills and real cases.
Please check the integration of the following subject: technical risks related to the process and manufacturing (mechanical constraints, aesthetics...) to anticipate during the design.
The training plan presented is very broad and goes beyond the question of 3D printing, addressing the themes of innovation and entrepreneurship.
The course is very complete for students.
The content is complete and progression adapted. A personalised training course will be interesting - Is it useful for institutions.
If I understood it correctly, it is a matter of pointing out the possibilities of using additive production, the basics of 3D modeling.
Each course is beneficial in education.
It seems that the course covers the main topics, however, afterwards the participants need to deepen their knowledge.
The needs of each group are well identified by the project.
If the participants do not have knowledge on CAD, it would be hard to have an adequate training for the defined learning hours.
I assume that work directly in the machine workshop is not included.
I cannot take a stand.
It is important to acquire new knowledge and skills.

9. Please indicate if you agree or disagree with the following statements:

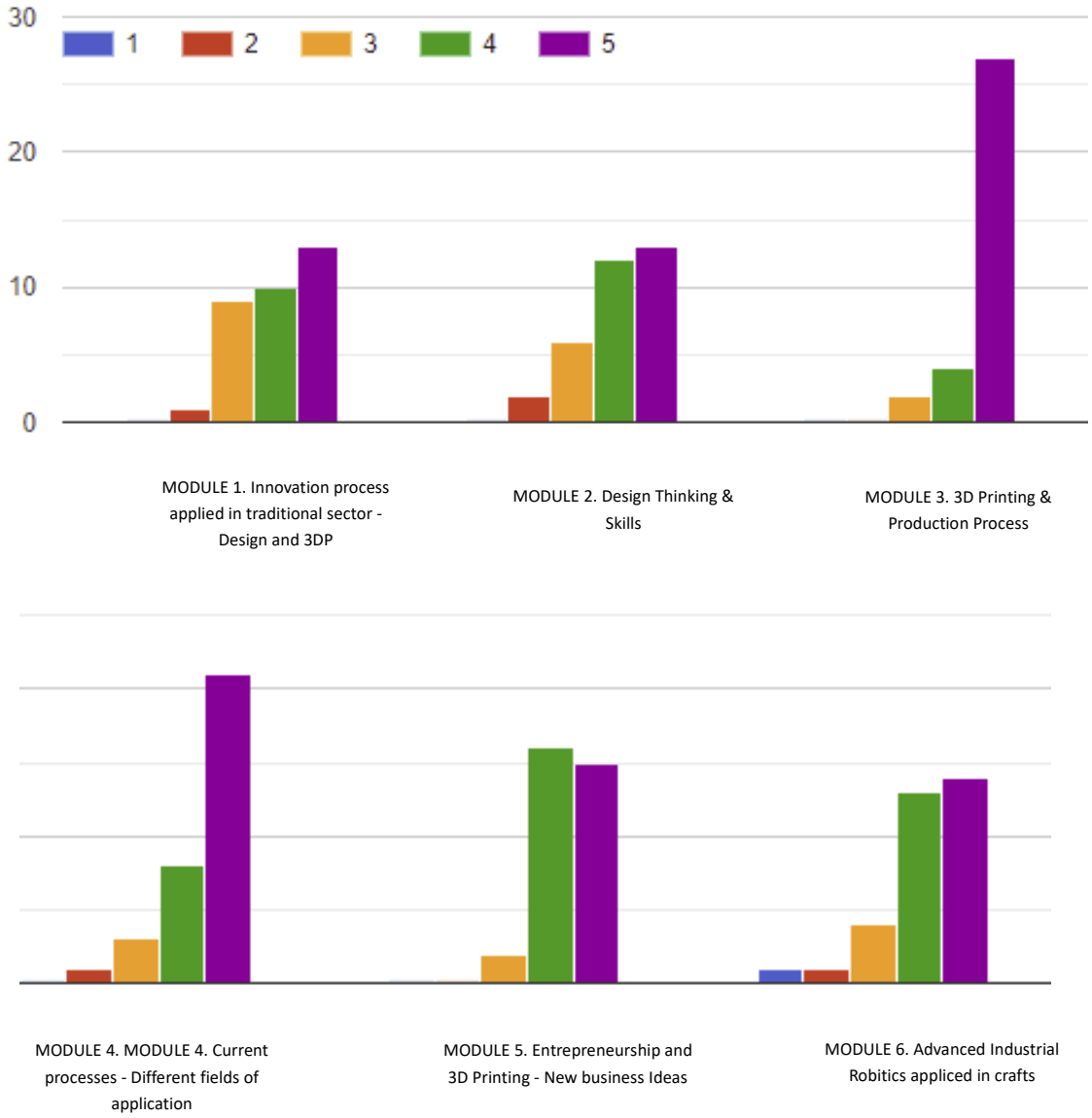
Table 32: Level of agreement on business opportunities, fostering the innovation and acquired knowledge for the target groups



A vast majority of stakeholders agree that the Joint Curriculum will encourage new business and foster innovation. The target group will acquire the necessary knowledge in 3D printing.

10. Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined modules:

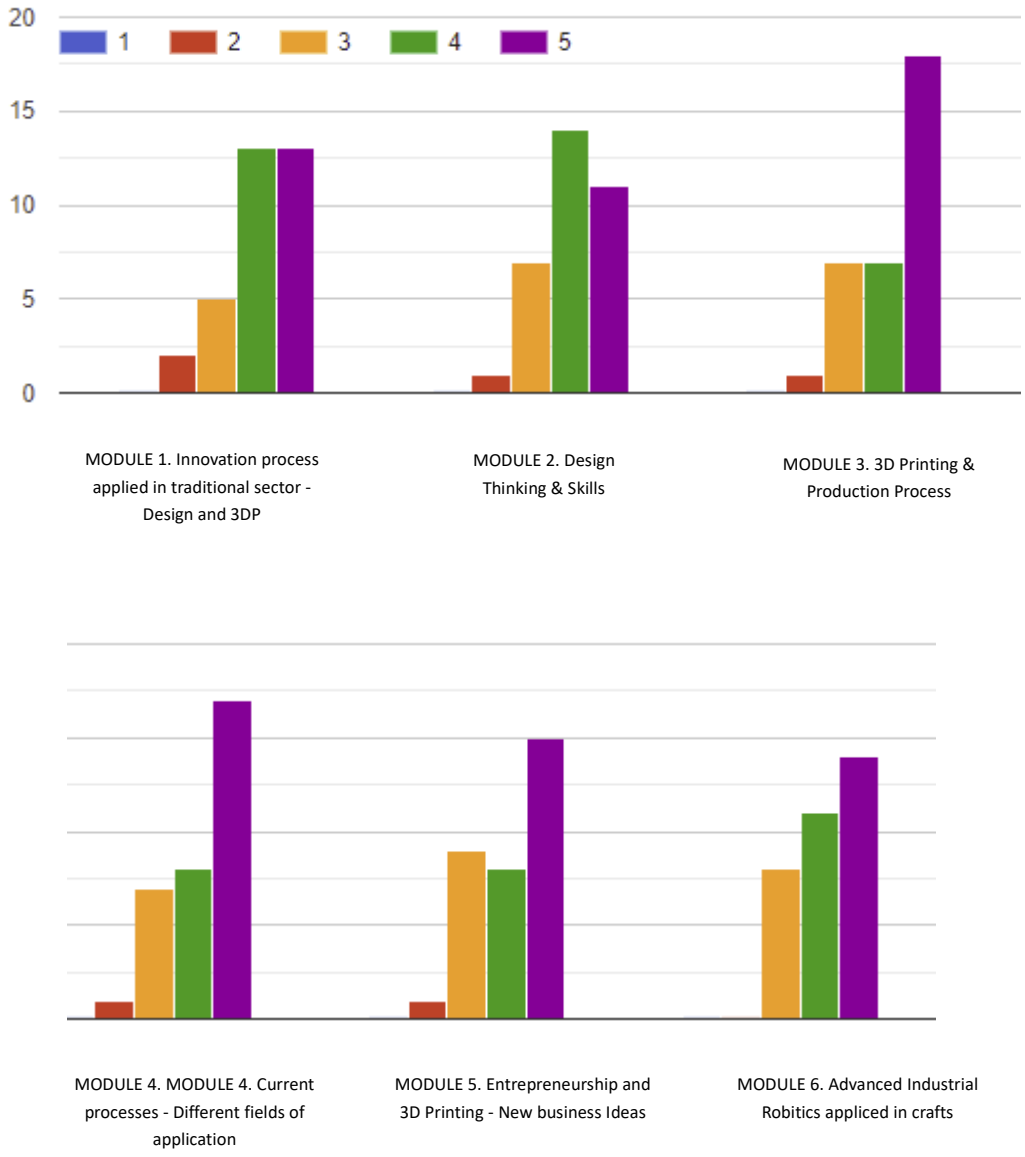
Table 33: Level of necessity per Module



The strong necessity for **Module 3** and **Module 4** shows a need to train participants in the most practical way and give them concrete examples in the 3D Printing and Production process and different fields of application. **Module 1** and **Module 2** were ranked as least necessary, probably because they cover topics that participants already know or think will not be needed as much as an actual 3D printing process.

11. Please rank with marks from 1 to 5 (with 5 being the highest) the suitability of the learning time distribution to each module:

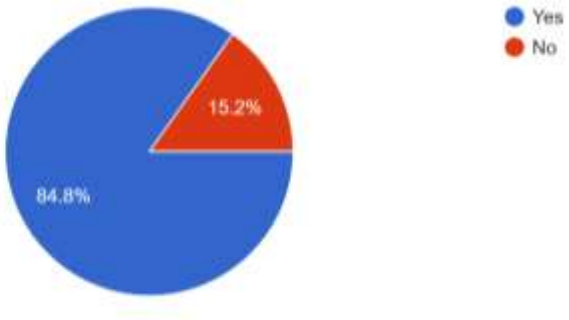
Table 34: Level of agreement with learning time distribution per Module



The time distribution among modules is adequate in all modules, with the highest-ranked for modules 3 and 4.

12. In your opinion, is the learning time dedicated to the whole course (250 hours) adequate?

Table 35: Level of the agreement for learning time dedicated to the whole course



The overall opinion shows stakeholders agree with learning time dedicated to the whole course.

13. If no, please explain your answer:

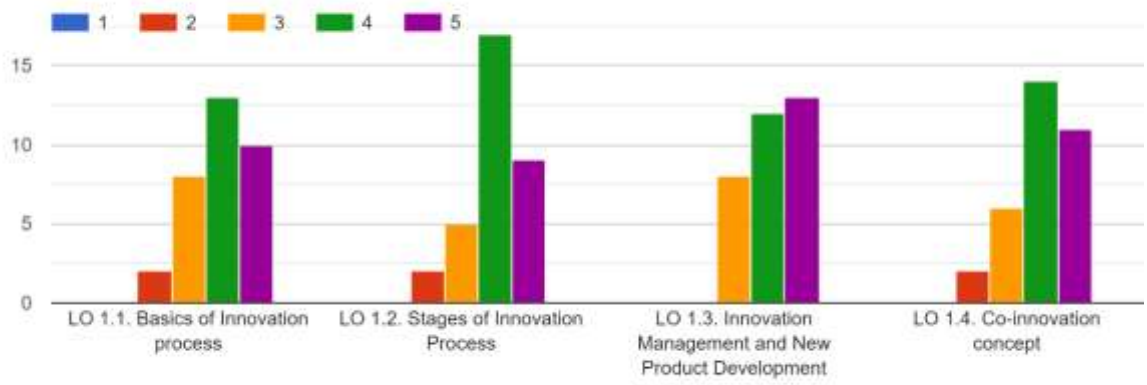
Stakeholders were asked to explain their answers. Comments refer to the course being too long for professionals and possibly shortening the hours' amount for the 1 and 2 and transferring those hours to module 6. The complete overview of the received comments is available below.

Table 36: Comments about the learning time dedicated to the whole course

It is a very extensive syllabus with many hours of dedication. Although the course looks pretty logical to me, I can't imagine profiles that will complete it. I think it is a good idea to create a free itinerary, in which each user decides what content they want to work on.
Yes and no: overall many hours for distance learning for target students ok if it's an expertise cycle. For other profiles, ok if the course can be lightened, customized.
I think this is far too important for small businesses and business start-ups. This can be adapted to students and large companies.
Notes: Many hours in total but better than not enough. Perhaps more hours for Module 6 and less for modules 1 et 2?
And no: To study all subjects takes 250h but it can be too long for companies.
For professionals, the course is way too long. The availability of the professionals is very short; they have no time. I would suggest a short version of the course with for example 100 hours.
I would shorten the time range for theoretical topics / blocks.

14. Module 1 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units:

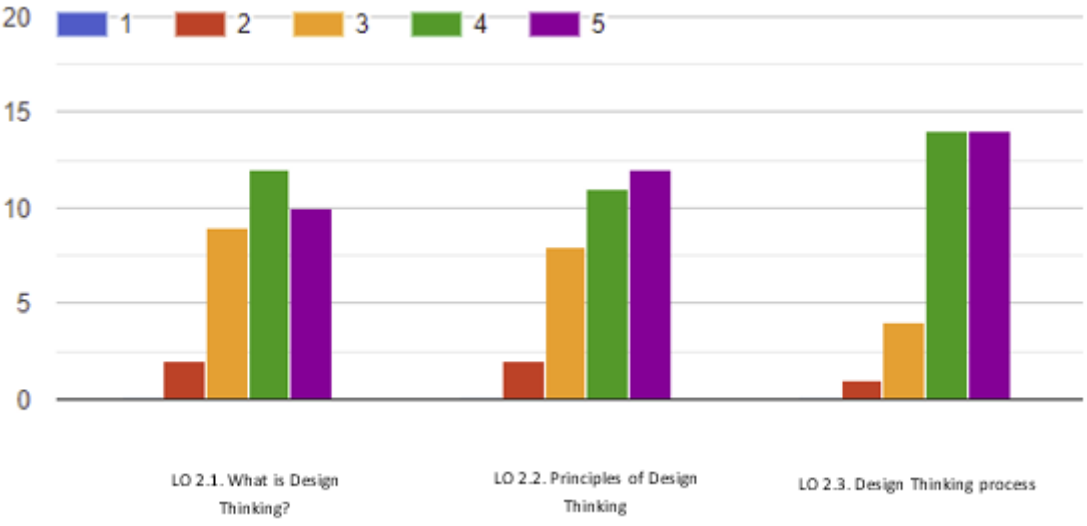
Table 37: Level of the necessity per learning units in Module 1

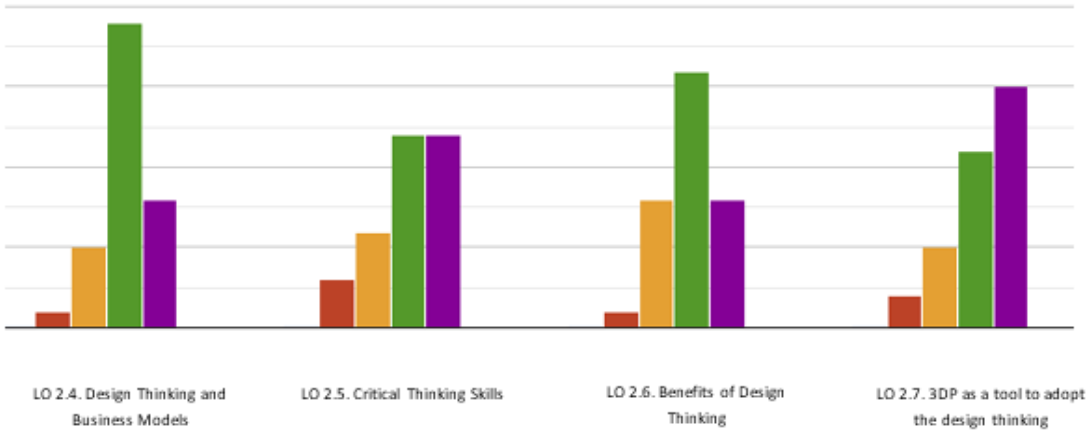


In Module 1, the stakeholders ranked higher the necessity of a training course covering the Stages of Innovation Process and Innovation Management with the New Products Development.

15. Module 2 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units:

Table 38. Level of the necessity per learning units in Module 2

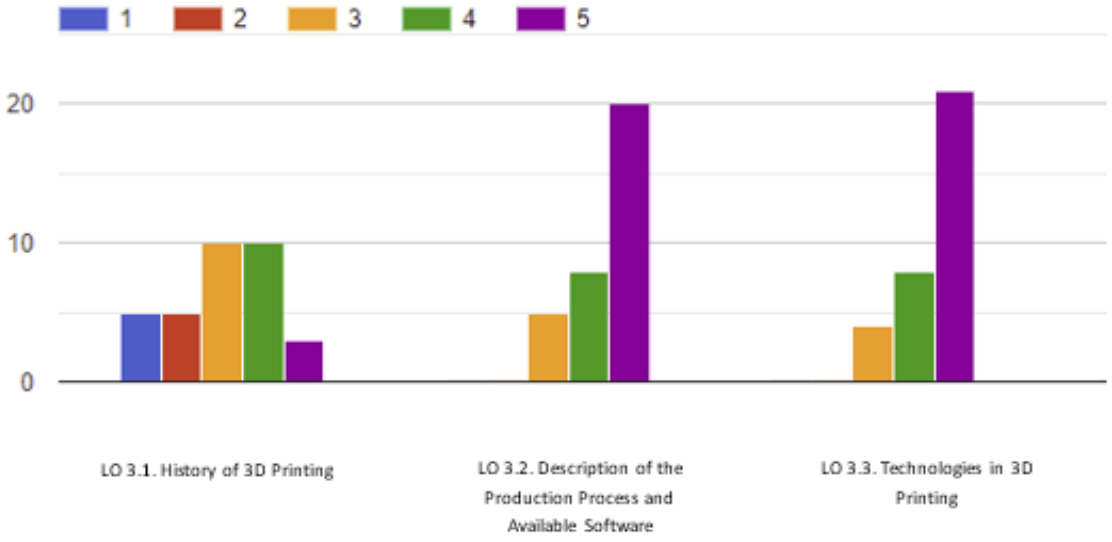


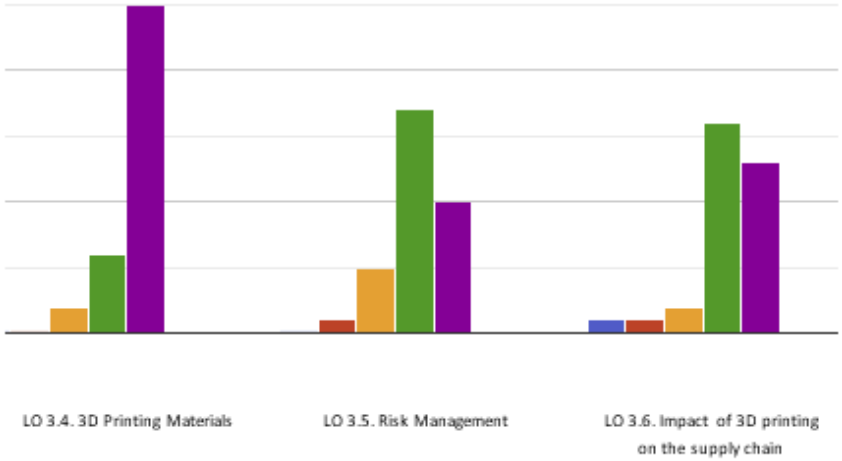


In Module 2, the stakeholders ranked higher the necessity to have a training course covering the Design Thinking process and 3DP as a tool to adopt the design thinking. No significant differences between more and less necessary learning units are shown.

16. Module 3 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units:

Table 39: Level of the necessity per learning units in Module 3

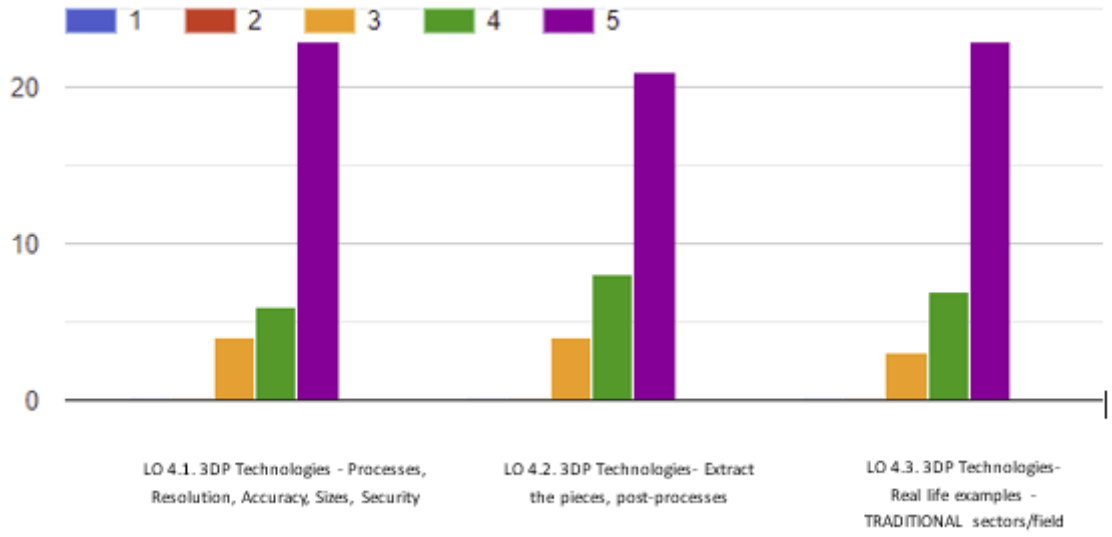


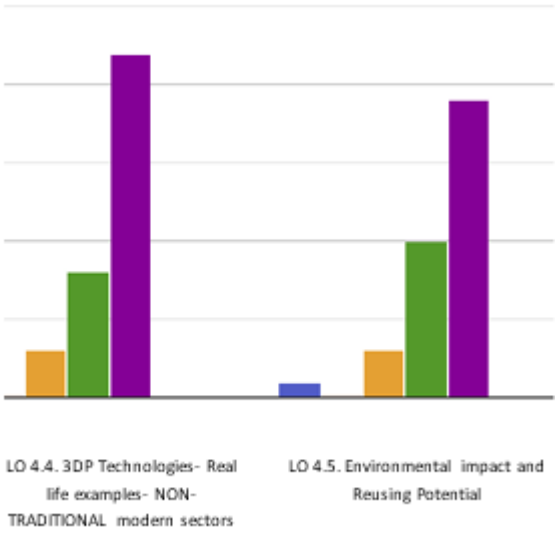


In Module 3, the stakeholders ranked higher the necessity to have a Description of the Production Process and Available Software, Technologies and Materials and impact on the supply chain. All this indicates the need to have more practical topics with less focus on the History of 3D printing (which was also ranked with the lowest mark by five stakeholders) and Risk Management.

17. Module 4 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units:

Table 40: Level of the necessity per learning units in Module 4

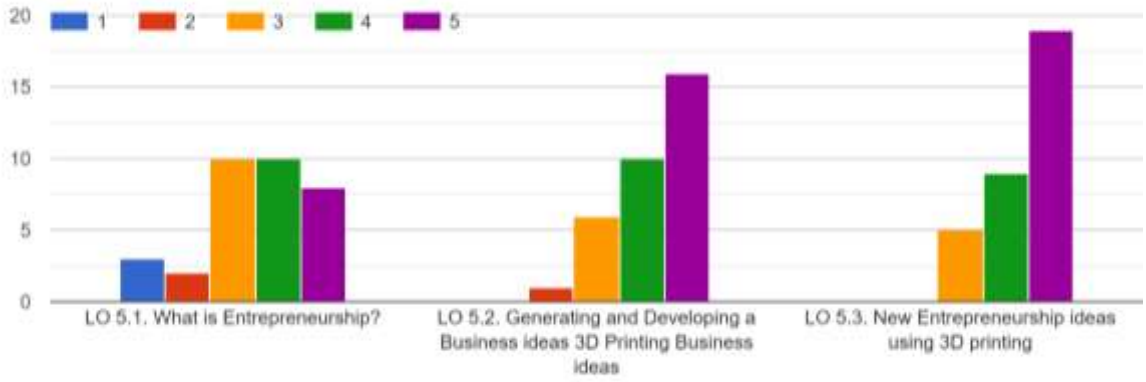




In Module 4, the stakeholders ranked all the learning objects very high, which indicates a great need to have topics like real-life examples in the learning material.

18. Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units:

Table 41: Level of the necessity per learning units in Module 5

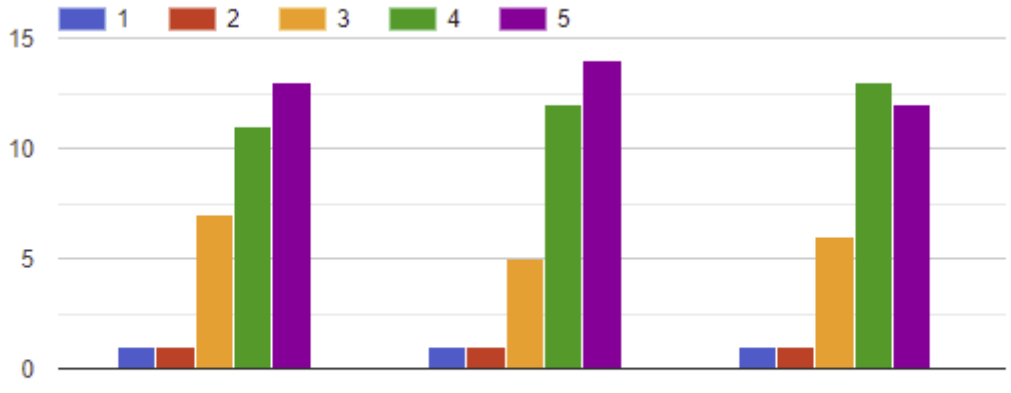


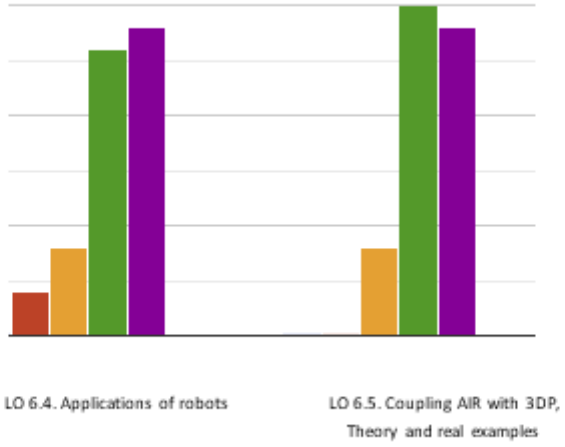
In Module 5, the stakeholders ranked with high marks the necessity of learning material to cover topics for generating and developing 3D printing business ideas. Based on marks, less focus should be dedicated to explaining what entrepreneurship is, which could be described with the fact that most of the stakeholders involved in the survey already know about it and don't find it necessary to be in the learning material.

19. Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these

defined learning units:

Table 42: Level of the necessity per learning units in Module 6

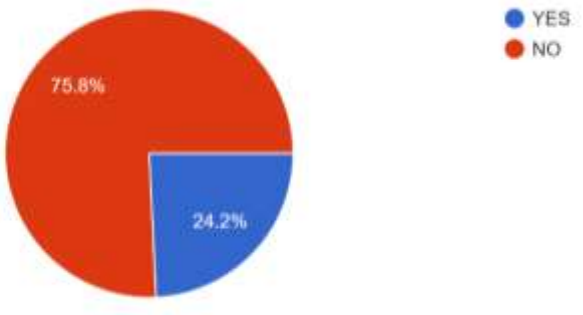




In Module 6, the stakeholders ranked all the learning objects very high, which indicates a great need to have topics about robotics in the ACCESS-3DP learning material.

20. Does the Joint Curriculum lack any important topic?

Table 43: Level of agreement on the lack of important topics



When asked whether the Joint Curriculum lacks any important topic, the majority agrees that there is no missing topic, while 24% of respondents think there is space for improvement.

21. If yes, please suggest a topic:

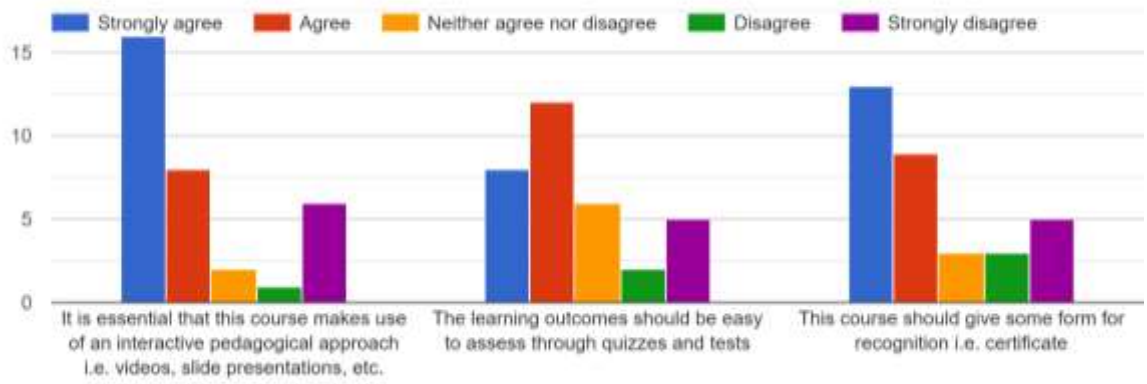
Stakeholders were asked to explain their answers if they thought topics were missing. Comments indicated that topics about the future with prospect and using the recycled material, reduced energy consumption. This topic will be covered in LO 4.5. Environmental impact and Reusing Potential. Stakeholders miss the material and machine cost topic and more practical module with the machine work and printing simple models. Also, the topics should include more about data sharing and open sources. All of these comments will be taken into consideration when developing the ACCESS-3DP training materials. However, it is important to notice that most generally had positive comments about the Joint Curriculum. The full overview of the received comments is available below.

Table 44: Comments about lack of any important topic in JC

3 topics: What about the future? prospects for evolutions in technology, materials and uses? Technical risks related to the process and manufacturing (mechanical constraints, aesthetics...) to anticipate during the design Environmental impact: Need to develop 3D printing taking into account environmental impacts (material recycling, energy consumption).
Perhaps consider a personal thread for each participant (delivery project). A concrete or fictional project that would lead the learner to ask questions throughout the training.
Provide elements to help with the choice: I do it myself/I subcontract.
Cost approach (material cost, machine cost, etc.)
Add: overview of the actors (fab of 3D imp, software, robot related to 3D imp Provide a section: to go further.
There is no practically module, a few hours to print a simple model.
Practice - work of participants on machines. According to the available info, I cannot clearly identify whether the individual trainings also include participation in workshops, work on one's own idea / case. If not, I would welcome her as a participant.
Sustainability, open source - data sharing, community creation.

22. Please assess the perceived benefits of the Joint Curriculum on the following statements:

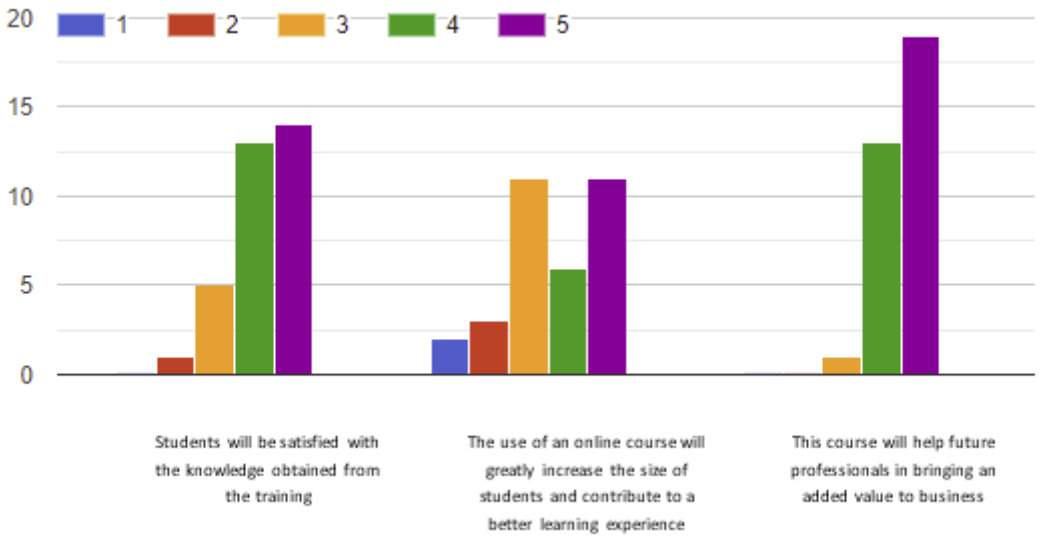
Table 45: Level of agreement on pedagogical approach, assessment, certification

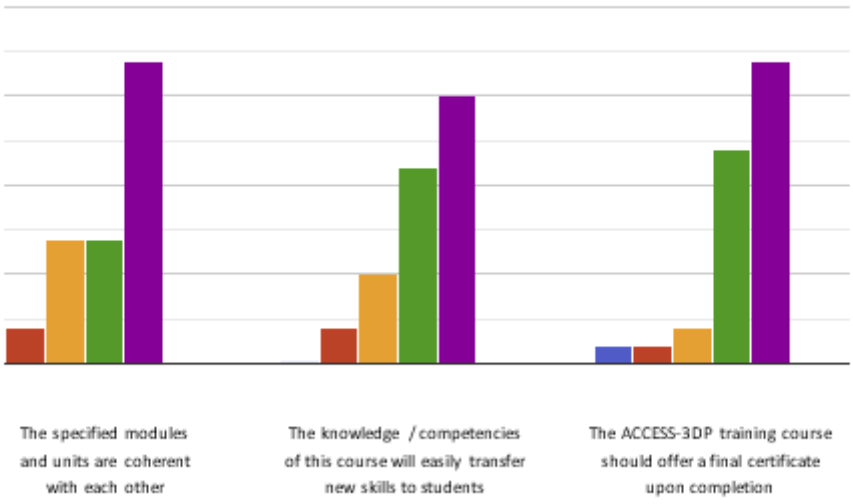


Stakeholders generally agree that the ACCESS-3DP course makes interactive pedagogical approaches and that a certificate should be issued upon completion. Most of them also agree on assessing the learning outcomes acquired by participants through quizzes and other testing tools.

23. Please rank with marks from 1 to 5 (with 5 being the highest) the key drivers for students moving forward with the Joint Curriculum:

Table 46: Level of importance of key drivers

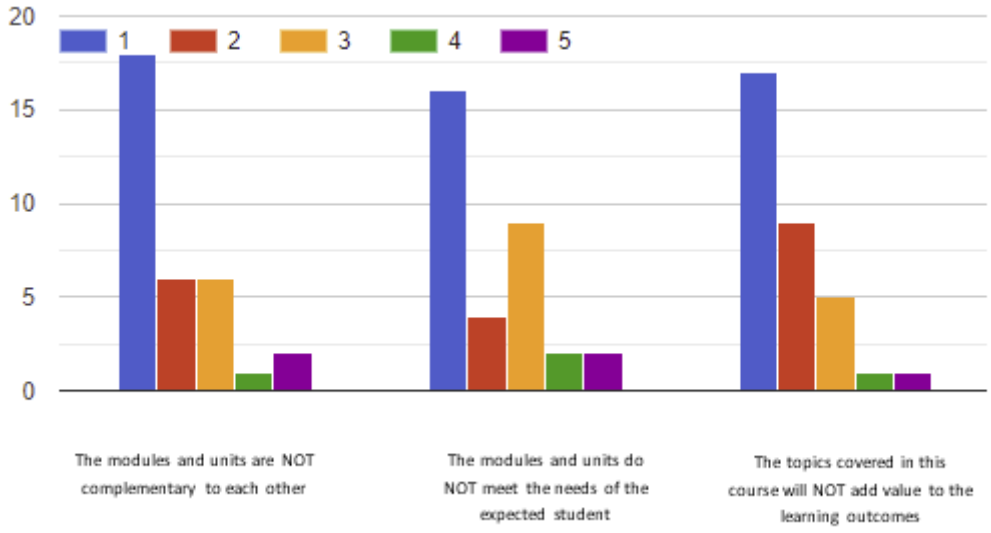


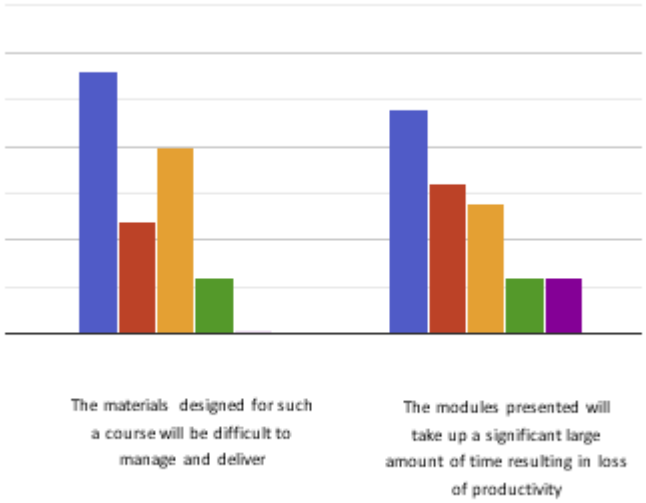


The overall assessments show that stakeholders agree that participants will be satisfied with the knowledge obtained, and the course will help bring added value to the business. The prevailing opinion is also that the course should offer a final certificate upon completion. They are less sure about the online course to significantly increase students' size and contribute to a better learning experience.

24. Please rank in order, 1 to 5 (with 5 being the highest) the main perceived barriers of this course:

Table 47: Level of agreement on perceived barriers





Generally, stakeholders do not perceive the barriers mentioned above to the Joint Curriculum, which is excellent. Instead, there is a slight doubt regarding the duration of the training. This means that partners should make sure to develop a short but practical ACCESS-3DP course.

26. Please leave any additional comments you may have concerned the ACCESS-3DP Joint Curriculum:

The comments left at the end of the questionnaire address different aspects. Some indicate that an interactive approach is needed because of the number of hours. The comments show that modules 2 and 5 could be shorter in the benefit of modules 3 and 4. More concrete topics should be included in modules 1, 2 and 5, and more issues about robotics would be welcome. Some comments also show that it would be good to give an even more appropriate evaluation – with pilot course evaluation. All of these comments will be taken into consideration when developing the ACCESS-3DP training materials. The complete overview of the received comments is available below.

Table 48: Comments related to the Joint Curriculum

Customization, interactivity is essential because of the volume of hours. Thinking about gamification of tests and validation of learning outcomes (i.e. play the seven errors).
To be relevant to small business: Leave the option to take all or part of the course Preselection for a progressive and adapted approach Generate interest by providing the opportunity to test.
Provide professionals with the opportunity to research what interests them quickly. Critical Self-Assessment to give learners the chance to repeat some topics which are not acquired. Online courses reach a wider audience, but face-to-face courses are better for knowledge transfer.
Avoid redundancies between modules 2 and 5 - modules 2 and 5 a little shorter for the benefit of modules 3 and 4 (Important technical info to aim for autonomy).
Go into concrete for Module 1-2 and 5 content - Allow learners to project based on examples, peer testimonies, etc.
The real interest of the online course is to capture, especially those far from major urban centres,

but testing in real is essential.
It could have more topics about robotics.
Congratulations on the excellent initiative.
Keep up the excellent work; I will be happy to join the course in the future.
I do have not enough knowledge to add any further comments.
This questionnaire is too long and before doing the actual course is impossible to have adequate answers. The course is too long. 250 hours for online training is way too long. It is fundamental to have presential training to, at least, some sessions. The success of the course is in the hands of the trainers. A pilot course with, for example, 20 participants should be done and then do the final evaluation of the course. I am available for any further comments.

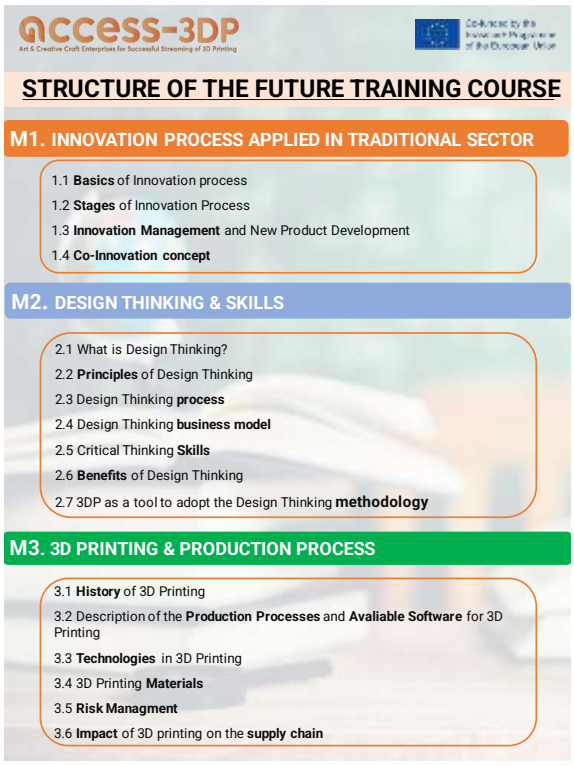
12. CONCLUSION

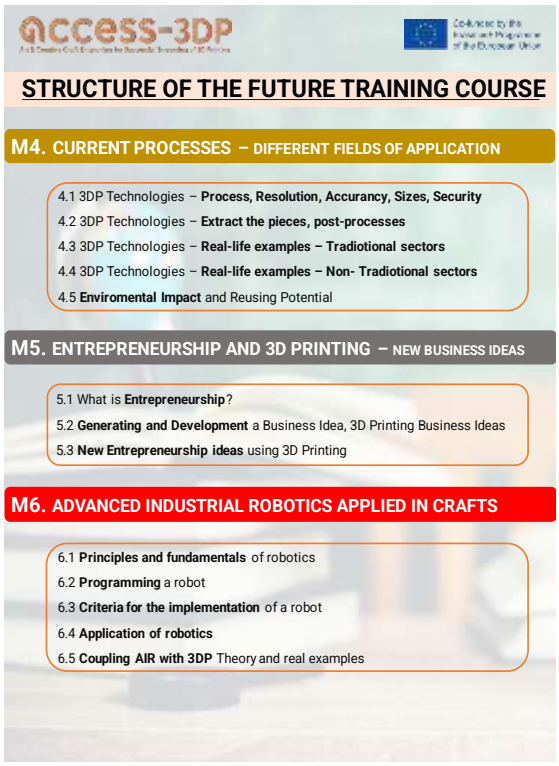
The **ACCESS-3DP training course** represents **six training modules with 30 learning objects**. Their structure and content are based on outcome key study in IO1. Each learning object addresses specific knowledge, skills, and competencies to achieve a good learning outcome. To implement the ECVET framework and EQF recommendations of the European Commission, points have been allocated to ensure that the training units fulfil the requirements.

- Units are defined based on the previously identified learning outcomes deriving from the key study of the needs of target groups. Each learning object addresses specific knowledge, skills and competencies that it aims at achieving.
- The ACCESS-3DP training course is weighted in terms of hours for each unit. Based on the estimated hours, ECVET points are allocated to each learning object.
- ACCESS-3DP addresses the EQF level 5 according to the European Qualification Framework and considers the differences between the consortium partner and their National Qualification Frameworks.

There is a general harmony between Modules and Learning objects. Since the topic of 3DP is relatively broad, the comments received are beneficial for the ACCESS-3DP partners to understand which topics require more attention than others and if there are aspects that shall be strengthened further. They will therefore be helpful to the development of the related training materials.
Generally, there is no significant weakness in the Joint Curriculum. Some aspects are more recurrent, while in general, the feedback is mostly positive. Nevertheless, the partners will consider each received input when improving the Joint Curriculum and transitioning towards the activities foreseen in Output 3.
In conclusion, the ACCESS-3DP training course will have a duration of **250 hours**, corresponding to **15 ECVET points**.

ANNEX 1 – JOINT CURRICULUM OVERVIEW


access-3DP
STRUCTURE OF THE FUTURE TRAINING COURSE
M1. INNOVATION PROCESS APPLIED IN TRADITIONAL SECTOR
1.1 Basics of Innovation process
1.2 Stages of Innovation Process
1.3 Innovation Management and New Product Development
1.4 Co-Innovation concept
M2. DESIGN THINKING & SKILLS
2.1 What is Design Thinking?
2.2 Principles of Design Thinking
2.3 Design Thinking process
2.4 Design Thinking business model
2.5 Critical Thinking Skills
2.6 Benefits of Design Thinking
2.7 3DP as a tool to adopt the Design Thinking methodology
M3. 3D PRINTING & PRODUCTION PROCESS
3.1 History of 3D Printing
3.2 Description of the Production Processes and Avaliable Software for 3D Printing
3.3 Technologies in 3D Printing
3.4 3D Printing Materials
3.5 Risk Managment
3.6 Impact of 3D printing on the supply chain


access-3DP
STRUCTURE OF THE FUTURE TRAINING COURSE
M4. CURRENT PROCESSES – DIFFERENT FIELDS OF APPLICATION
4.1 3DP Technologies – Process, Resolution, Accurancy, Sizes, Security
4.2 3DP Technologies – Extract the pieces, post-processes
4.3 3DP Technologies – Real-life examples – Tradiotional sectors
4.4 3DP Technologies – Real-life examples – Non- Tradiotional sectors
4.5 Enviromental Impact and Reusing Potential
M5. ENTREPRENEURSHIP AND 3D PRINTING – NEW BUSINESS IDEAS
5.1 What is Entrepreneurship?
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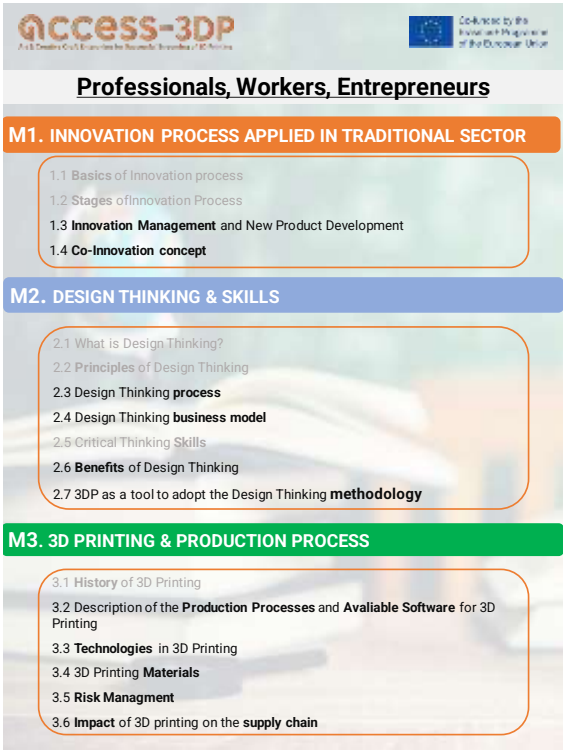
6.1 Principles and fundamentals of robotics
6.2 Programming a robot
6.3 Criteria for the implementation of a robot
6.4 Application of robotics
6.5 Coupling AIR with 3DP Theory and real examples


access-3DP
Professionals, Workers, Entrepreneurs
M1. INNOVATION PROCESS APPLIED IN TRADITIONAL SECTOR
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1.2 Stages ofInnovation Process
1.3 Innovation Management and New Product Development
1.4 Co-Innovation concept
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2.2 Principles of Design Thinking
2.3 Design Thinking process
2.4 Design Thinking business model
2.5 Critical Thinking Skills
2.6 Benefits of Design Thinking
2.7 3DP as a tool to adopt the Design Thinking methodology
M3. 3D PRINTING & PRODUCTION PROCESS
3.1 History of 3D Printing
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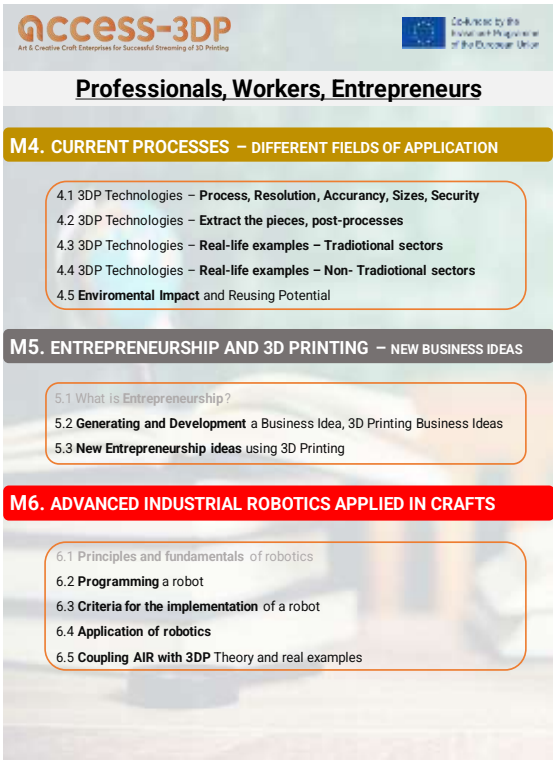
3.3 Technologies in 3D Printing
3.4 3D Printing Materials
3.5 Risk Managment
3.6 Impact of 3D printing on the supply chain


access-3DP
Professionals, Workers, Entrepreneurs
M4. CURRENT PROCESSES – DIFFERENT FIELDS OF APPLICATION
4.1 3DP Technologies – Process, Resolution, Accurancy, Sizes, Security
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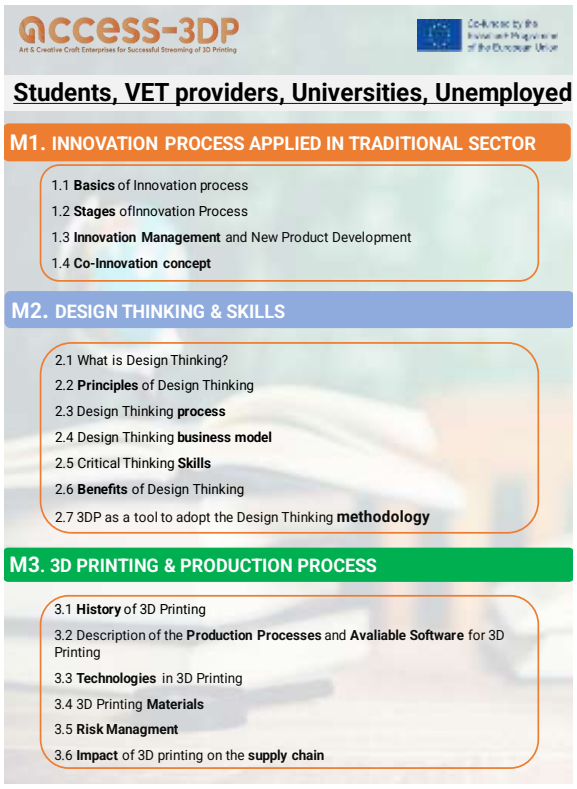
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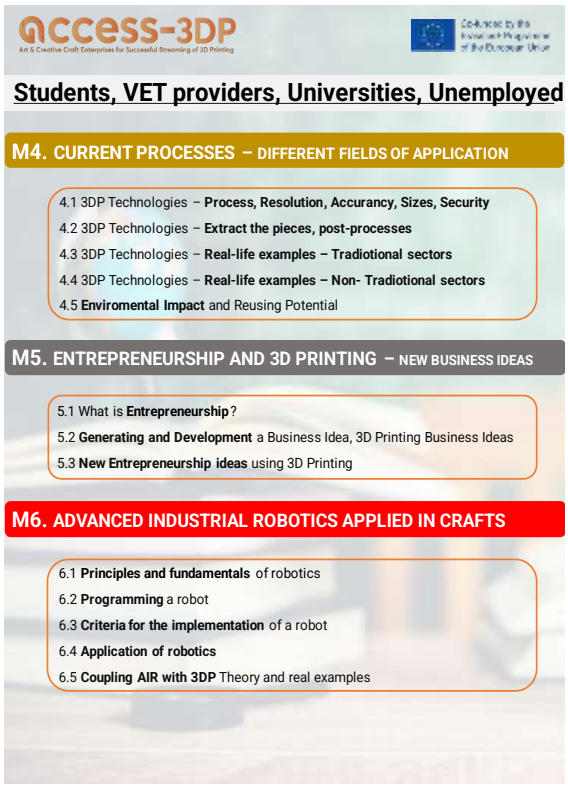
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Other relevant stakeholders, Local authorities
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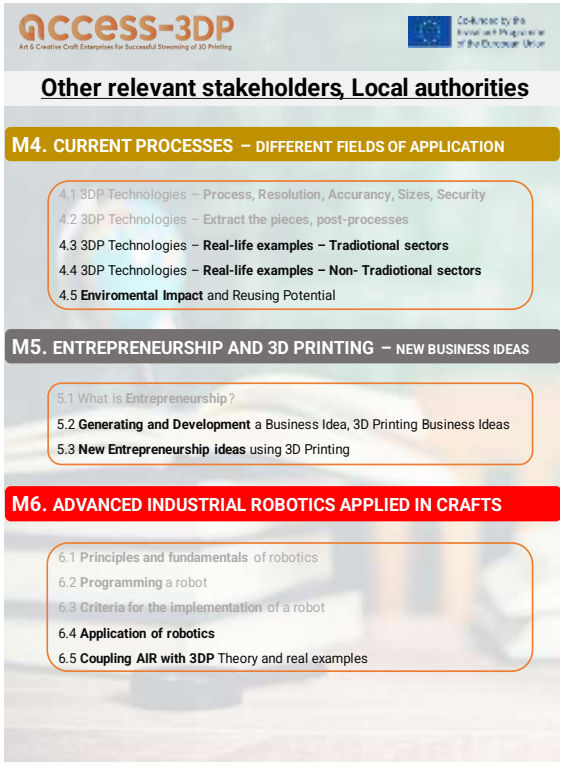
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ANNEX II – QUESTIONNAIRE FOR THE JOINT CURRICULUM VALIDATION

QUESTIONNAIRE FOR VALIDATION OF THE JOINT CURRICULUM

The ACCESS-3DP project, co-funded by Erasmus+ Programme, aims to develop a new training course focusing on additive manufacturing in traditional-craft and creative industries. It brings together an innovative Consortium of 5 partners with experts in 3D Printing and design from the VET, HE world and business organizations from creative industries from 5 EU countries.

The ACCESS-3DP project targets groups of (1) Professionals, Workers, Entrepreneurs, (2) Students, VET providers, Universities, Unemployed and (3) Other relevant Stakeholders (Traditional Sector, Local Educational Authorities, Policy-Makers).

You are kindly requested to complete the following survey about the prepared Joint Curriculum. Before proceeding, please check the Joint Curriculum overview available on this link: https://view.genial.ly/613cf27054e6970d68fc79d3/learning-experience-didactic- unit-access-3dp-joint-curriculum

Confidentiality and GDPR: please note that we will not publish sensitive data such as name, surname and email address, following the General Data Protection Regulation fromMay 2019. The information sent via this form is stored until after the project ending for internal usage and it will be available only to project partners.

*Required

ACCESS-3DP

Art & Creative Craft Enterprises for Successful Streaming of 3D Printing

General informations:

1. Name of your organization: *

2. Position within the organization: *

Country: *

4. Please provide your e-mail if you accept to join a mailing list of ACCESS-3DP project contacts to receive periodical information with the last project progress and final results as well as some promotional material of the project:

Evaluation of the Joint Curriculum

The ACCESS-3DP course target three main target groups: (1) Professionals, Workers, Designers, Entrepreneurs, (2) Students, VET providers, Universities, Unemployed, and (3) Other relevant Stakeholders (Traditional Sectors, Local Educational Authorities, Policy-Makers). Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined training paths: *

Mark only one oval per row.

	1	2	3	4	5
Professionals, Workers, Entrepreneurs	◯	◯	◯	◯	◯
Students, VET providers, Universities, Unemployed	◯	◯	◯	◯	◯
Other relevant Stakeholders ((Traditional Sector, Local EducationalAuthorities, Policy–Makers))	◯	◯	◯	◯	◯

Each of the previous target groups will have a different training path suggested for them and, after its successful completion, they will receive a certificate of the course. Do you consider it necessary to receive this certificate? *

Mark only one oval.

◯ Yes
◯ No

If not, please explain your answer:

Apart from the specific training path for the different target groups, there will be a training path opened to all users interested in gaining the knowledge and skills they are looking for, but without receiving certification in the end. Please rank with marks from 1 to 5 (with 5 being the highest) the necessity of this defined "Open-access course - without certification": *

Mark only one oval.

- 1
- 2
- 3
- 4
- 5

Do you agree that students for this open-access course don't receive certificate? *

Mark only one oval.

- Yes
- No

If not, please explain your answer:

In your opinion do you think the Joint Curriculum properly addresses the needs of the target groups to enhance the knowledge, skills, and competencies in 3D Printing? *

Mark only one oval.

- ◯ It greatly fulfils those needs.
- ◯ It somewhat fulfils those needs.It
- ◯ partially fulfils those needs.
- ◯ It poorly fulfils those needs.

Please, explain your answer:

Please indicate if you agree or disagree with the following statements: *

Mark only one oval per row.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
The described Joint Curriculum will encouragenew business opportunities	◯	◯	◯	◯	◯
The Joint Curriculum will foster innovation in different business sectors	◯	◯	◯	◯	◯
The target group will acquire necessary knowledge in 3D Printing	◯	◯	◯	◯	◯

Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined modules: *

Mark only one oval per row.

	1	2	3	4	5
MODULE 1. Innovation process applied in traditional sector – Designand 3DP	◯	◯	◯	◯	◯
MODULE 2. Design Thinking & Skill's	◯	◯	◯	◯	◯
MODULE 3. 3D Printing & Production Process					
MODULE 4. Current processes – Different fields off application					
MODULE 5. Entrepreneurship and 3D Printing – New business Mideast					
MODULE 6. Advanced Industrial Robotics applied in crafts					

In your opinion, is the learning time dedicated to the whole course (250 hours) adequate? *

Mark only one oval.

◯ Yes

◯ No

If no, please explain your answer:

Module 1 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units: *

Mark only one oval per row.

	1	2	3	4	5
LO 1. 1.. Basics off Innovation process LO	◯	◯	◯	◯	◯
1. 2.. Stages off Innovation Process	◯	◯	◯	◯	◯
LO 1. 3.. Innovation Management and New Product Development	◯	◯	◯	◯	◯
LO 1. 4.. Co–innovation concept	◯	◯	◯	◯	◯

Module 2 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units: *

Mark only one oval per row.

	1	2	3	4	5
LO 2. 1.. What is Design Thinking?	◯	◯	◯	◯	◯
LO 2. 2.. Principles off Design ThinkingLO	◯	◯	◯	◯	◯
2. 3.. Design Thinking process	◯	◯	◯	◯	◯
LO 2. 4.. Design Thinking andBusiness Models	◯	◯	◯	◯	◯
LO 2. 5.. Critical Thinking Skill's	◯	◯	◯	◯	◯
LO 2. 6.. Benefits off Design Thinking	◯	◯	◯	◯	◯
LO 2. 7.. 3DP as a tool to adopt the design thinking methodology for craft and entrepreneur	◯	◯	◯	◯	◯

Module 3 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units: *

Mark only one oval per row.

	1	2	3	4	5
LO 3. 1.. History off 3D Printing					
LO 3. 2.. Description off the Production Process and Valeyable Software					
LO 3. 3.. Technologies in 3D PrintingLO					
3. 4.. 3D Printing Materials					
LO 3. 5.. Risk Management					
LO 3. 6.. Impact off 3D printing on the supply chain					

Module 4 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units: *

Mark only one oval per row.

	1	2	3	4	5
LO 4. 1.. 3DP Technologies -- Processes,, Resolution,, Accuracy, Sizes, Security					
LO 4.2. 3DP Technologies-- Extractthe pieces, post--processes					
LO 4. 3.. 3DP Technologies-- Real life examples --TRADIITIIONAL sectors/field					
LO 4. 4.. 3DP Technologies-- Real life examples-- NON TRADIITIIONAL modern sectors					

Module 5 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units: *

Mark only one oval per row.

	1	2	3	4	5
LO 5. 1.. What is Entrepreneurship?	◯	◯	◯	◯	◯
LO 5. 2.. Generating and developing a business ideas 3D Printing Business ideas	◯	◯	◯	◯	◯
LO 5. 3.. New Entrepreneurship ideas using 3D printing	◯	◯	◯	◯	◯

Module 6 - Please rank with marks from 1 to 5 (with 5 being the highest) the necessity for each of these defined learning units: *

Mark only one oval per row.

	1	2	3	4	5
LO 6. 1.. Principles fundamentals off robotics	◯	◯	◯	◯	◯
LO 6. 2.. Programming a robot	◯	◯	◯	◯	◯
LO 6. 3.. Criteria for the implementation off a robot	◯	◯	◯	◯	◯
LO 6. 4.. Applications off robots	◯	◯	◯	◯	◯
LO 6. 5.. Coupling AIIR with 3DP, Theory and real examples	◯	◯	◯	◯	◯

Does the Joint Curriculum lack any important topic? *

Mark only one oval.

◯ YES
◯ NO

If yes, please suggest a topic:

Please assess the perceived benefits of the Joint Curriculum on the following statements: *

Mark only one oval per row.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
It is essential that this course makes use off an interactive pedagogical approach i.e., videos, slides, etc.					
The learning outcomes should be easy to assess through quizzes and tests					
This course should give some form for recognitionie., certificate					

Please rank with marks from 1 to 5 (with 5 being the highest) the key drivers for students moving forward with the Joint Curriculum. *

Mark only one oval per row.

	1	2	3	4	5
Students will be satisfied with the knowledge obtained from the training	◯	◯	◯	◯	◯
The use off an online course will greatly increase the size off studentsand contribute to a better learning experience	◯	◯	◯	◯	◯
This course will help future professionals in bringing an addedvalue tot business	◯	◯	◯	◯	◯
The specified modules and units are coherent with each other	◯	◯	◯	◯	◯
The knowledge / competencies off this course will easily transfer new skills tot students	◯	◯	◯	◯	◯
The ACCESS--3DP training course should offer a final certificate uponcompletion	◯	◯	◯	◯	◯

Please rank in order, 1 to 5 (with 5 being the highest) the main perceived barriers of this course. *

Mark only one oval per row.

	1	2	3	4	5
The modules and units are NOT complementary to teach other	◯	◯	◯	◯	◯
The modules and units do NOT meetthe needs off the expected students	◯	◯	◯	◯	◯
The topics covered in this course willNOT add value to the learning outcomes	◯	◯	◯	◯	◯
The materials designed for such a course will be difficult to manageand deliver	◯	◯	◯	◯	◯
The modules presented will take upa significant large amount off time resulting in loss off productivity	◯	◯	◯	◯	◯

Please leave any additional comments you may have concerning the ACCESS-3DP Joint Curriculum: