ALLIES

Digital Training Tools in Steel Structure Integrity

Steel Structures Integrity Curricula

PR3

Project coordinator:

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INTRODUCTION

Over the past few years, several European tools have been developed and put into action with the goal of improving qualification transparency, permeability, and recognition among EU members as well as internationally, with a strong emphasis on promoting quality of education and training throughout all qualification cycles. ALLIES Project Result 3 – Elaboration of new steel structures integrity curricula based on competence units makes use of two of these tools European Qualifications Framework (EQF) and The European Credit Transfer and Accumulation System (ECTS) for higher education.

This curriculum was developed following EWF´s methodological approach to the design of Qualifications which implies the use of a common terminology applicable to all its Qualifications, developed on a modular basis where each Qualification comprehends a set of Competence Units, organized in Learning Outcomes.

EWF considers CEDEFOP "education and training glossary" (2023) to facilitate the understanding of Vocational Education and Training (VET) main concepts, such as:

Qualification: A formal outcome (certificate, diploma or title) of an assessment process which is obtained when an individual has achieved the required learning outcomes. It includes the job requirements: knowledge, skills, autonomy and responsibility required to perform specific tasks attached to a particular work position. In terms of structure, a Qualification is composed by a definition of a certain professional profile and a respective Curricula, containing all the activities related to the design, organisation and planning of its education or training actions.

Competence Unit: Components of qualifications, consisting of a coherent set of knowledge and skills, organized in learning outcomes and minimum or recommended workload, that can be individually assessed and validated.

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

Workload: The estimation of the time learners typically needs to complete all learning activities such as lectures, seminars, projects, practical work, work placements, individual study required to achieve the defined learning outcomes in formal learning environments.

Our aim is to present a post graduated curriculum in steel structure integrity based on competence units, within the framework of the ALLIES project. This approach increase flexibility on training

pathways by allowing students do complete competence units separately and combined them in a more adaptable way concerning their professional profile needs.

CURRICULUM DESIGNING

A key component of how we teach, train, and participate in formal learning experiences is curriculum design. A mental model of learning and a design representation of knowledge and skill transfer from theory to practice are the core of the process of planning formal learning experiences.

Curriculum design is operationally defined as the intentional planning, organization, and design of learning strategies, processes, materials, and experiences towards defined learning outcomes. Curriculum design is creating an integrative plan for the environments where learning happens considering the physical, digital, social, and psychological factors that define the spaces and places where people learn.

Historically the design of curriculum used to begin by defining content or topics focused on the big picture of professional profile. The process which is now broadly used is the one which starts by the end, with the mind in the **learning outcomes**. Curriculum is more likely to be results focused and efficient. Centred in what the learned will be capable of doing is a start to address levels of qualification and standards, the content, topics, pedagogical strategies, learning environments and assessment specifications.[1]

Defining learning outcomes as the statements of what a **what a learner is expected to know** and **is able to do** on **completion** of a **learning process**, defined in terms of **Knowledge**, **skills** and **autonomy and responsibility** (Council of the European Union, 2017).

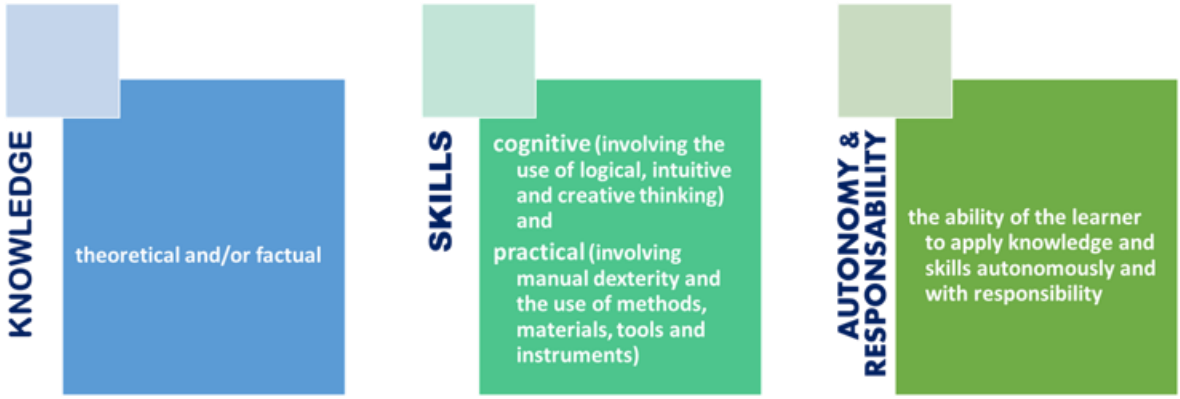

Figure 1 Learning Outcomes Components

Learning outcomes describe how the learning experience impact on the learner. It's about what the learner gain from the experience of learning and how it is relevant and meaningful for him or her. A

[1] McDonald, J. K. & West, R. E. (2021). *Design for Learning: Principles, Processes, and Praxis (1st ed.)*. EdTech Books. https://dx.doi.org/10.59668/id

clear and well formulated learning outcome will help guide your design process towards a good result.

One of the important tools is **Bloom's Taxonomy,** a framework that classifies educational objectives and learning outcomes. The taxonomy provides a hierarchical structure for categorizing cognitive skills and knowledge acquisition. It helps educators design instructional activities and assessments that align with different levels of thinking.

In 2001, Bloom's Taxonomy was revised to reflect a more active and learner-centred approach. The revised taxonomy uses action verbs to describe the cognitive processes associated with each level: Remembering, Understanding, Applying, Analysing, Evaluating, and Creating.

Educators often use Bloom's Taxonomy as a guide to develop curriculum, lesson plans, and assessments that progressively challenge students to engage in higher-order thinking skills and deeper understanding of the subject matter.

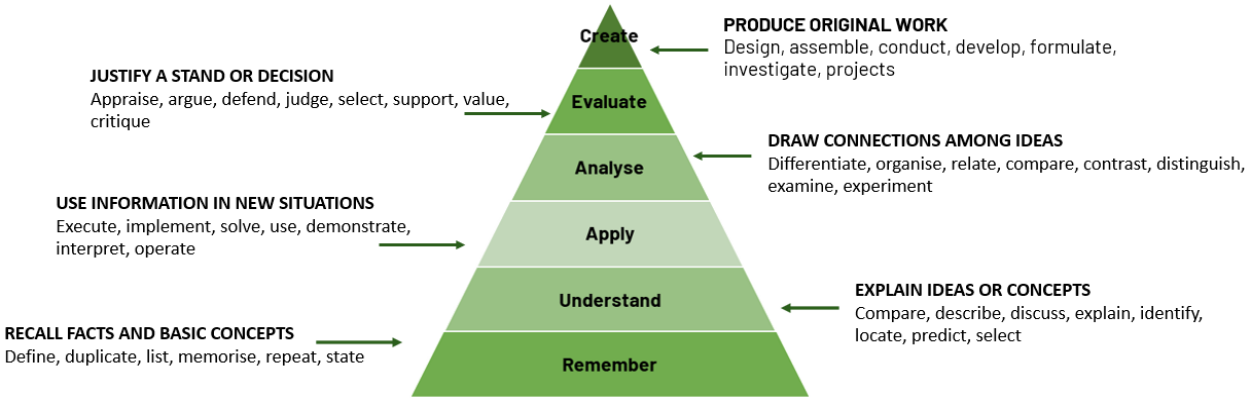

Figure 2 Bloom's Taxonomy

When building a curriculum, the aspects of what a learner is expected to know and be able to accomplish (learning outcomes) are organised into Competence Units. ALLIES curriculum is structured into Competence Units that are autonomously evaluated and validated. Each Competence Unit comprehends several subunits providing specific fields of application and corresponding learning outcomes. In terms of structure, the Competence Units are organized into the following elements:

Actions/achievements – observable actions through which the individual demonstrate mastery of the Competence Unit. They reflect the professional application of the combined learning outcomes foreseen for each submodule.

Performance criteria – the quality requirements associated with performance, reflecting the level of complexity that the actions must have.

The combination of the actions/achievements with the performance criteria provides the complexity depth for the establishment of the **European Qualifications Framework** (**EQF) level.** In this way, the

Learning Outcomes break down into knowledge application, practical application and competences as statements of what a learner knows, understands and is able to do as foreseen in the EQF descriptors, that are mobilized in actions/achievements through which the individual shows/demonstrates the required field of competence, according to a certain performance criteria and context conditions.

This methodological approach gives performance requirements that contribute for the increase of transparency in terms of assessment elements, enabling a clarification for learners and trainers in regard to the expected outcomes, ensuring a learner centred approach and a more effective comparability and mutual recognition among the different VET Providers/Systems.

The European Qualifications Framework is a common reference framework that helps education and training entities, employers and individuals across Europe to compare qualifications in the different education and training systems, facilitating mobility of trainees and workers in the EU in the process. Thus, the adoption of EQF increases mobility of workers and trainees and contributes to the recognition of their qualifications outside their own countries.

The EQF tool is based on Learning Outcomes (LOs) whose main reference level descriptors are:

- Knowledge,
- Skills,
- Autonomy and Responsibility (Attitudes).

QUALIFICATIONS	LEVEL	LEARNING OUTCOMES		
		KNOWLEDGE	SKILLS	RESPONSABILTY AND AUTONOMY
		Theoretical and/or factual.	Cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments)	The ability of the learner to apply knowledge and skills autonomously and with responsibility
MASTER DEGREE	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
BACHELOR DEGREE	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
POST-SECUNDARY NON-HIGHER EDUCATION QUALIFICATION	5	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 performance of self and others
UPPER SECUNDARY EDUCATION THROUGH VOCATIONAL AND EDUCATIONAL TRAINING (DOUBLE QUALIFICATION)	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

Figure 3 Learning Outcomes Descriptors align with EQF levels

For promoting a culture of lifelong learning, it is essential that people can access quality education and training allowing upskilling and reskilling throughout their lives in a way that all stakeholders,

particularly employers can recognise the achieved knowledge, skills, competence, and responsibility to perform a professional role within the expected level.

The use of the European Transfer and Accumulation System (ECTS), a tool of the European Higher Education Area (EHEA) gives a certain number of credits based on the workload and achieved learning outcomes by a student after the completion of a qualification degree. The ECTS gives learners mobility and flexibility to integrate different types of learning and different learning contexts, like study abroad with a secure process of recognising qualifications and periods of study. Nowadays ECTS is a reality applied in all high education qualification programmes, as it is referred on the ECT's User Guide 2 "ECTS is a learner-centred system for credit accumulation and transfer, based on the principle of transparency of the learning, teaching and assessment processes. Its objective is to facilitate the planning, delivery and evaluation of study programmes and student mobility by recognising learning achievements and qualifications and periods of learning." A full-time academic year (1,500 to 1,800 hours) or its equivalent gives a student a 60 ECTS credits, based on learning outcomes assessed through transparent and clear procedures and its associated workload. Which indicates that 25 to 30 hours of effort equal 1 ECT. It should be understood that this represents the normal workload and that individual students will require different amounts of time to complete their learning objectives.

Challenges in into labour market due to the constantly digital transformation, needs for new skills towards work methods and procedure always in innovation, leads to a labour market in constant changing and looking for a skilled, trained and adaptable workforce. People need to face lifelong learning as part of their life. Continuous upskilling and reskilling are essential for keep employability. Even for economic concerns, the employment market is increasingly in need of short- and extremely short-term courses. Responding to the immediate demands of the labour market requires training that is applied to and focused on solving problems quickly. An industry can encourage short-term training for the development of specialised skills for the fulfilment of a specific task or obligation, but it cannot stop teaching its people prolonged qualifications. Promoting learner access for those with fewer possibilities due to economic or social settings through short-term courses also contributes to social inclusion. This reality leads to micro-credentials which can help to substantially widen learning and skills development opportunities, and further shape the lifelong learning dimension.

A **micro-credential** is a proof of the learning outcomes that a learner has acquired following a short learning experience. Micro-credentials could help certify the outcomes of small, tailored learning experiences. They make possible the targeted, flexible acquisition of knowledge, skills and competences to meet new and emerging needs in society and the labour market and make it possible

[2] ECTS users' guide 2015 - Publications Office of the EU (europa.eu)

for individuals to fill the skill gaps they need to succeed in a fast-changing environment, while not replacing traditional qualifications. They can, where appropriate, complement existing qualifications, providing added value while not undermining the core principle of full degree programmes in initial education and training.[3]

Micro-credentials mean the record of learning outcomes that a learner has acquired following a learning experience. These learning outcomes should be assessed against transparent and clearly defined criteria.

ALLIES STEEL STRUCTURES INTEGRITY CURRICULUM

ALLIES Project aims to contribute to the digital transition stimulating the use of innovative learning and teaching practices, by development a new modular postgraduate course targeting steel structures integrity based on online digital tools. ALLIES postgraduate curriculum is designed on a learner centered approach, organized in a modular short-term course in order to offer micro-credentials, promoting flexibility, portability and "stackability", creating the possibility to combine different micro-credentials and build adaptable and meaningfully learning pathways.

The addressed learners for the ALLIES steel structure integrity post graduate curriculum are mechanical engineers with a bachelor's degree so the designed curriculum will focus on levels 5 and 6 of the EQF.

QUALIFICATIONS	LEVEL	LEARNING OUTCOMES		
		KNOWLEDGE	SKILLS	RESPONSABILTY AND AUTONOMY
		Theoretical and/or factual.	Cognitive (involving the use of logical, intuitive and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools and instruments)	The ability of the learner to apply knowledge and skills autonomously and with responsibility
MASTER DEGREE	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
BACHELOR DEGREE	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
POST-SECUNDARY NON-HIGHER EDUCATION QUALIFICATION	5	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 performance of self and others
UPPER SECUNDARY EDUCATION THROUGH VOCATIONAL AND EDUCATIONAL TRAINING (DOUBLE QUALIFICATION)	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

Figure 4 Learning Outcomes Descriptors align with EQF levels – ALLIES curriculum

For the designing of the Curriculum, we need to describe the target group, who need this training course?

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52021DC0770

- What is the general description of this professional profile concerning its main tasks and responsibilities?
- What is the required previous knowledge (academic background) and/or experience in the field to attend the course?
- What level of complexity and depth should be achieved in terms of knowledge, skills, autonomy, and responsibility at the end of a qualification process?

  Key questions:

  - What job functions and activities are required?

ALLIES Professional Profile

RESPONSABILITIES (Which responsibilities is expecting this person to have)	TASKS (which tasks this person is going to do)
• To evaluate if the approach used in RBI is conform with the guidelines, law, standards. • To select the RBI level concerning the guidelines and standards. • Make the decision of the selection of the NDT to be used according to the characteristics of the structure • Interpret and evaluate the integrity of steel structures through computerized simulation and modelling tools.	• Assess requirements and constraints • Evaluate of level of risk • Evaluate the most effective NDT to be adopted. • Definition of a preliminary plan maintenance inspection • Based on the results of the modelling and finite elements analysis, evaluate the level of risk of the steel structure • Reports the damage mechanism identify on the structure through the simulation • Support modelling and designing a steel structure

Table 1 ALLIES Steel Structures Integrity Curriculum Professional Profile

To align the Competence Units created for ALLIES with EQF, the consortium wrote its LOs centered on learners' point of view (following a new LOs approach that focuses on defining precise and observable learning results).

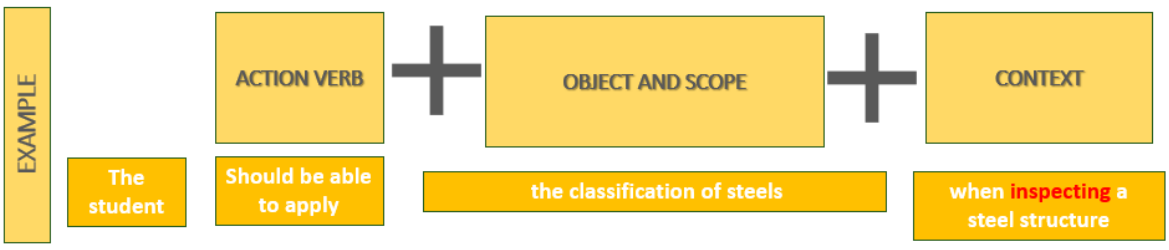

Figure 5 Learning Outcomes Basic Structure

In order to visualize the Steel Structure Integrity training curriculum, the contents of theoretical Modules/Competence Units are presented, in terms of:

a. **Learning Outcomes** – described in terms of knowledge and skills, as previously mentioned.

b. **Detailed Knowledge** – Description of the level of knowledge/Qualification each Module/CU addresses and of the contents of each subject title.
c. **Contact hours** –Minimum contact hours for each subject title.
d. **Workload (WL)** – Is an estimation of the time learners typically need to achieve the defined learning outcomes. WL covers theoretical training and self-study, as well as the time devoted to practical training and examination. The time needed for the completion of each Module/CU may vary individually, according to the capability of the trainee,
e. **Assessment procedures** – describe the assessment methodologies indicating the methods and measures. As an example, assessment can be made through tests, presentations, questionnaires. **ECT /ECVET** – European Credit System for Vocational Education and Training. Credit points are allocated to Modules/Competence Units, where 1 credit equals 25 to 30 hours of workload .

Competence Unit 1 “STEEL STRUCTURE INTEGRITY INSPECTION”

Competence Unit 1 **STEEL STRUCTURE INTEGRITY INSPECTION**	**CONTACT HOURS**	**WORKLOAD**
SUBJECT TITLE		
Introduction to Risked Based Inspection	2	4
Non-Destructive Testing	4	8
Standards, Rules and Specifications	2	4
Case Studies	6	12
Total	**14**	**28**
ECT	**1**	

LEARNING OUTCOMES – STEEL STRUCTURE INTEGRITY INSPECTION	
KNOWLEDGE	To have a comprehensive and specialised knowledge of: • Risk Based Inspection (RBI) • Non-Destructive Testing (NDT) • Standards, rules and specifications on steel structures integrity
SKILLS	At the end of this CU is expecting that students will be able to: • Identify and interpret guidelines, standards and applicable law related to the infrastructure assigned. • Assess requirements and constraints on the use of the RBI when the infrastructures are assigned and the resources available. • Evaluate the level of risk of a steel structure according to a given reference. • Verify the most effective NDT according to the materials and type of structures. • Design a preliminary plan maintenance inspection

DETAILED KNOWLEDGE	
QUALIFICATION	**6**
CONTACT HOURS	**12**
DEPTH	**6**
Introduction to Risked Based Inspection (RBI) - Definitions - Main Influencing Factors - Risk Analysis and Inspection Planning - Assessment questionnaire	2
Non-Destructive Testing - Review of applicable NDT techniques - Criteria of NDT application - Identification of surface preparation to perform NDT - Coating and Surface Conditions - Inspection of Welded and Bolting Joints - Assessment questionnaire	4
Standards, Rules and Specifications -Examples of European Manufacturing Standard (EN 1090-2/-3) -Examples of Supplementary Rules for Specific Constructions - Assessment questionnaire	2
Case studies -Examples of Infrastructures and Relative “Main Structural Elements” -Detection of Expected Damage -Application of Inspection Approaches Including Risk-Based Inspection -Practical Training on Case Studies (Digital) - Case Study Assessment	6

Competence Unit 2 "COMPUTER AND SIMULATION IN STEEL STRUCTURE INTEGRITY DESIGN"

Competence Unit 2 **COMPUTER AND SIMULATION IN STEEL STRUCTURE INTEGRITY DESIGN**	**CONTACT HOURS**	**WORKLOAD**
SUBJECT TITLE		
Introduction to Design of Steel Structures	4	8
Introduction to Modelling and Simulation	4	8
Main Types of Damage Mechanisms	4	12
Total	**12**	**28**
ECT	**1**	

LEARNING OUTCOMES – COMPUTER AND SIMULATION IN STEEL STRUCTURE INTEGRITY DESIGN	
KNOWLEDGE	Advanced knowledge and critical understanding of the theory, principles, and applicability of: • Steel structures designing • Basics modelling and simulation • Acknowledgment of the main types of damage mechanisms
SKILLS	At the end of this CU is expecting that students will be able to: • Read and interpret technical draw of the structure. • Interpret and understands the result of the finite elements analysis. • Use specific designing software in the design of steel structures. • Simulate trough digital tools steel structure integrity. • Use digital tools in modelling steel structures. • Identify potential design issues after performing the steel structure integrity simulation. • Identify the main damage mechanism acting in the structure inspected. • Evaluate the integrity risks and define mitigate actions

DETAILED KNOWLEDGE	
QUALIFICATION	
CONTACT HOURS	**12**
DEPTH	**5**
Introduction to Design of Steel Structures - Basics of Design - Classification of Steels - Standard References (e.g., Eurocode) - Assessment questionnaire	4
Introduction to Modelling and Simulation - Basics of Modelling - Basics of Simulation - Finite Element Analysis - Assessment questionnaire	4
Main Types of Damage Mechanisms - Mechanical Damage Mechanisms - Environmental Damage Mechanisms - Assessment questionnaire	4

DIGITAL TOOLS IN LEARNING PROCESSES

Digital tools have transformed the educational landscape, offering a plethora of advantages for both learners and educators. These tools enhance learning by incorporating interactive elements, multimedia content, and gamified experiences, fostering student engagement and motivation. Also, digital tools provide access to a vast array of resources, including online libraries, educational websites, videos, and interactive simulations, enriching students' understanding and broadening their horizons. Moreover, they facilitate collaboration and communication, promoting peer learning and developing essential communication skills. Additionally, digital tools enable flexible learning environments, allowing students to learn at their own pace, in their own time, and in their preferred setting. In today's digital world, these tools empower students with the skills necessary for success in the 21st century. As technology advances, digital tools are poised to play an even more transformative role in shaping the future of education.

Therefore, in the scope of the ALLIES project, within project result 2 New Methodologies for Teaching using Digital Tools, was map out general tools used in blended learning methodologies (including microlearning), concerning their benefits and characteristics. This approach allowed to narrow down the digital learning tools recommended to be used concerning the training of the developed curriculum. From this mapping, was concluded that the use of digital tools in the teaching and learning process, for the field of steel structures, brings meaningful benefits for students, by providing enriched learning experience and facilitating the understanding of key concepts, while promoting the development of technical and professional skills. Therefore, were identified, selected and organized by theme an assortment of digital tools (such as Soldamatic, BIM Steel Structures Inc., BEM Software, REVIT Software, Rhino, COMSOL, CIVA), targeted to the delivering of the ALLIES Curriculum.

ASSESSMENT METHODOLOGY

In the realm of education, assessment methodologies play a pivotal role in evaluating learner achievement and guiding instructional practices. According to Cedefop (2023, No 125, p. 64) assessment is a process that involves compiling evidence on the learners' individual progress against assessment criteria. Thus, assessment methodologies are essential tools for evaluating learner achievement and guiding instructional practices. These methodologies provide a systematic approach to gathering, interpreting, and utilizing evidence of learning, ensuring that assessments are aligned with learning outcomes, fair and equitable for all learners, and yield meaningful feedback to promote growth and development. Therefore, guaranteeing the quality of the assessment approach (including methods, tools and instruments) needs to be assured (Cedefop,2023, No 125, p. 64). Also, assessment methodologies provide a systematic approach to gathering, interpreting, and using evidence of learning. So, well-defined methodology ensures that assessments are aligned with learning outcomes, fair and equitable for all learners, and provide meaningful feedback to promote growth and development. Considering that "learning-outcomes-based assessment (…) makes it easier to reflect and respect individual variation in learning careers, accepting differences in how, where and when learning took place" Cedefop (2023, No 124, p. 16-17). Therefore, assessments should be carefully designed to measure what students are expected to know, understand, and be able to do as defined by the learning outcomes. This alignment ensures that assessments are meaningful and provide a valid measure of student achievement.

Emerging within the educational landscape is the concept of micro-credentials, which represent digital badges or certifications that signify an individual's mastery of specific skills or competencies. According to the council recommendation on a European approach to micro-credentials for lifelong learning and employability (2022, p. 4) micro-credentials "(…) make possible the targeted, flexible acquisition of knowledge, skills and competences to meet new and emerging needs in society and the labour market and make it possible for individuals to fill the skill gaps they need to succeed in a fast-changing environment, while not replacing traditional qualifications." Therefore, offer a versatile and granular approach to recognizing and validating learning, providing a more comprehensive representation of an individual's skillset compared to traditional credentials.

In the scope of the ALLIES Curriculum was developed within the project result 4 Digital Learning Materials and Real-Life Study Cases self-assessment tools, namely in the form of multiple-choice questions and case studies. Promoting assessment as an ongoing and formative process, and as a tool to provide regular feedback to students throughout their learning journey.

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