SkiComCu-Lifelong Learning Course for skills & competences in the Copper sector

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Project short title:	SkiComCu-LL
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Project duration:	36 months

D3.1 Modular Training Curriculum and Materials (course design)

Internal Identifier:	BP2025-EITRM216812
Description:	The task leader, NTUA, with the support of all partners, and especially UPM and FCT NOVA, will develop the structure and content of a modular training curriculum including all types of skills described in WP3, as defined in WP2. The curriculum and materials will include a) an overview of the curriculum, b) the modules and c) a companion for each module outlining the most efficient pedagogic methods for the specific type of skills the modules cover. *Updated version of D3.1 (BP2024-EITRM122077) [M15]*
Included in BP year:	2025
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Table of Contents

Executive Summary 1

Objectives, and EIT Impact Framework and KIC Impact 2

Objectives 2

EIT Impact Framework and KIC Impact 2

Training Delivery Model and Pedagogical Approach 3

Asynchronous Delivery 3

Synchronous Delivery 4

SkiComCu Curriculum Overview 5

SkiComCu – Supply Chain of Copper 5

SkiComCu – Extractive Waste Management 6

SkiComCu – Physical Metallurgy 7

SkiComCu – Health & Safety 8

SkiComCu – Soft Skills 9

Training Modules Structure 10

Conclusions 11

Executive Summary

This updated version of D3.1 presents the finalised SkiComCu modular training curriculum and the complete set of training materials developed during the reporting period. Building on the outcomes of WP2 and the needs identified by the industrial partners, NTUA designed a comprehensive five-module curriculum including copper supply chain, extractive waste management, physical metallurgy, health and safety, and soft skills. All modules have been fully developed in SCORM format and integrated into the Learning Point platform, complemented by synchronous training resources, detailed presentations, slide notes, supplementary learning material, assessment tests and case studies.

The curriculum follows a hybrid learning model that combines asynchronous online modules with interactive synchronous sessions, ensuring both flexibility and strong practical relevance. The pedagogical approach is grounded in competence-based education and Bloom's Revised Taxonomy, supporting progressive skill development across different professional levels. This updated deliverable consolidates all improvements made since M15 and confirms the successful completion of the curriculum design activities planned under WP3.

Objectives, and EIT Impact Framework and KIC Impact

Objectives

Objective	Description	Status
SkiComCu modular educational material development	Development of the updated and finalised SkiComCu modular training curriculum, including the structure, content, learning outcomes and pedagogical design of the five modules. Incorporation of revisions made since the initial version (M15), ensuring full alignment with the goals of WP3.	Achieved

EIT Impact Framework and KIC Impact

Deliverable "D3.1 Modular Training Curriculum and Materials (course design)" contributes to the realization of the following KPIs, as stated in the project's BP: KPI KICN01-11: Improve the gender balance in the RM sector, EITHE02: Innovations Launched on the Market and EITHE08: Graduates from NON-Labelled Education Activities, Programs, and Trainings.

Training Delivery Model and Pedagogical Approach

The SkiComCu pedagogical approach is built on the principles of competence-based education, ensuring that learners can transfer newly acquired knowledge, technologies, and sustainable practices directly into real industrial settings. The learning objectives follow Bloom's Revised Taxonomy, enabling a structured progression from basic comprehension to higher-level analytical and creative problem-solving across the stages of Remember, Understand, Apply, Analyze, Evaluate, and Create. This educational design reinforces the goals of the EIT RawMaterials Lighthouse initiatives on Circular Societies and Responsible Sourcing and is fully aligned with key Sustainable Development Goals, including SDG 4 (Quality Education), SDG 8 (Decent Work), SDG 9 (Industry & Innovation), and SDG 12 (Responsible Consumption & Production).

The SkiComCu curriculum is delivered through a hybrid learning model that strategically combines asynchronous (online) modules with synchronous (in-person/live-online) sessions. This integrated approach ensures both flexibility and pedagogical depth, enabling trainees to build foundational knowledge independently while also engaging in interactive, practice-oriented activities guided by trained instructors.

Asynchronous Delivery

The asynchronous component provides self-paced learning through the EIT RawMaterials Learning Point platform. All modules are developed in SCORM format using Articulate Rise and follow contemporary principles of instructional design, microlearning, and visual engagement. Lessons are structured into short, focused units that incorporate concise text, images, videos, interactive figures, flip cards, GIFs, and diagrams. These elements support conceptual understanding, maintain learner motivation, and ensure consistency across modules.

Each lesson concludes with a short self-assessment quiz offering immediate feedback, allowing learners to monitor their progress and consolidate key concepts. The platform's responsive design, progress indicators, and intuitive navigation ensure accessibility across devices and accommodate diverse learning preferences. The asynchronous modules also serve as essential preparation for synchronous sessions, enabling participants to arrive with a solid grasp of core content.

Synchronous Delivery

The synchronous delivery follows a train-the-trainers model, where trainers can be trained to deliver the curriculum across different professional levels of the copper industry. Each module is supported by a dedicated PowerPoint presentation that mirrors the structure of the asynchronous content and includes detailed slide notes to guide clear, accurate, and consistent instruction.

Synchronous sessions emphasize active learning, contextualization, and collaborative problem-solving. Trainers integrate real-world industrial examples and case studies, as well as team-based activities that connect theoretical knowledge to operational challenges. This approach strengthens the practical application of skills and encourages peer learning, cross-disciplinary dialogue, and reflective practice.

To enhance engagement, trainers may incorporate digital facilitation tools such as quizzes, polls, collaborative boards, and real-time feedback platforms. These tools help maintain attention, check understanding, and stimulate participation. Sessions begin with a brief recap of asynchronous content, followed by interactive exploration of key concepts, and conclude with a reflection or take-home message to reinforce learning. The

synchronous training materials, including presentations, supplementary learning materials, assessment tests and case studies, are available through the project's SharePoint repository.

SkiComCu Curriculum Overview

SkiComCu – Supply Chain of Copper

This module provides a comprehensive understanding of the copper supply chain, encompassing both primary and secondary resources, beneficiation methods, metallurgical processing, by-products handling, market dynamics, and environmental aspects. It targets a wide audience, from engineers and geoscientists to managers and policymakers, enhancing effective cross-disciplinary communication and supporting informed decision-making for sustainable copper production and use.

SCORM file (Articulate Rise link): Supply Chain of Copper

Learning Outcomes:

- Describe the main stages of the copper supply chain, from resource extraction and beneficiation to refining, recycling, and end-use applications.
- Differentiate between primary and secondary copper resources, explaining their global distribution, extraction methods, and relative contributions to supply.
- Explain ore beneficiation and scrap recycling techniques, including flotation, leaching, and other separation processes.
- Analyze the principles and applications of pyrometallurgical and hydrometallurgical routes for copper production.
- Identify key by-products and copper compounds generated through the supply chain and assess their economic and industrial significance.
- Evaluate the environmental impacts of copper production, including mining tailings, slags, off-gases, and leaching residues, and discuss mitigation strategies.
- Interpret global market trends, production data, and substitution challenges to understand the strategic importance of copper in the clean energy transition.
- Assess the role of Environmental, Social, and Governance (ESG) practices in ensuring sustainability, ethical sourcing, and stakeholder engagement throughout the copper supply chain.

Trainee / Trainer Qualification Requirements:

Participants should have a basic understanding of industrial processes, materials, or resource management. Prior exposure to mining, metallurgy, or environmental management is beneficial but not required.

Training Content Developers / Educators:

Dr. Michail Samouchos (NTUA), Dr. Anastasia Alexandratou (NTUA), Prof. Maria Taxiarchou (NTUA)

SkiComCu – Extractive Waste Management

Extractive waste management is a critical aspect of sustainable resource extraction, focusing on the responsible handling and disposal of waste generated by mining and mineral processing. As demand for natural resources increases, effective management of extractive waste becomes essential to minimize environmental impact, protect public health, and ensure compliance with EU regulatory standards. This introductory module covers the core principles of waste characterization, classification, and rehabilitation, with emphasis on the copper industry. By understanding the complexities of extractive waste, participants gain insight into innovative solutions that balance economic growth with environmental stewardship.

SCORM file (Articulate Rise link): Extractive Waste Management

Learning Outcomes:

- Analyze the legal and regulatory frameworks governing the sustainable management of Cu extractive waste within the EU.
- Evaluate the physical and geochemical properties of Cu extractive waste and assess their relevance to classification and management strategies.
- Examine disposal systems used for Cu extractive waste and identify associated site-specific risks and stabilization measures to ensure physical and chemical integrity
- Explore and assess leading technologies and best practices for recycling, reuse, and reclamation of Cu extractive waste and legacy disposal facilities.

Trainee / Trainer Qualification Requirements:

Participants should have a general awareness of mining/metallurgical operations and environmental protection principles. Familiarity with EU environmental legislation or industrial waste management practices is desirable but not essential.

Training Content Developers / Educators:

Em. Prof. Katerina Adam (NTUA), Researcher Evangelia Mylona (NTUA)

SkiComCu – Physical Metallurgy

This module is aimed at professionals across the copper value chain. This module deepens understanding of the principles of physical metallurgy and their application to process optimization and sustainable manufacturing. It connects fundamental science with practical performance analysis, supporting the transition toward Industry 4.0 practices.

SCORM file (Articulate Rise link): Physical Metallurgy

Learning Outcomes:

- Identify and explain the fundamental crystal structures of metals, with emphasis on copper and its alloys.
- Analyze how atomic bonding, dislocations, and grain structures influence the mechanical and physical properties of metals.
- Interpret phase diagrams to predict microstructural evolution during solidification and processing.
- Correlate the microstructures of copper alloys, as observed through microscopy, with their processing history and performance.
- Apply principles of casting, solidification, and thermal treatments to optimize copper alloy microstructures and properties.
- Evaluate processing defects and propose corrective measures based on metallurgical principles.
- Recognize the role of computational and digital tools (e.g., FEM, phase-field modelling, AI-based analysis) in supporting design and process optimization.
- Assess the role of physical metallurgy in the copper value chain and adapt knowledge for Industry 4.0 and sustainable manufacturing practices.

Trainee / Trainer Qualification Requirements:

Participants should have a basic knowledge of materials science, and a background in physics or engineering is recommended. No prior experience with computational modelling tools is necessary.

Training Content Developers / Educators:

Dr. Alexandros Banis (NTUA), Dr. Vasilis Loukadakis (NTUA), Prof. Spyros Papaefthymiou (NTUA)

SkiComCu – Health & Safety

This module introduces participants to the fundamental principles and practices of health and safety management in industrial environments, with emphasis on mining and metallurgical operations.

SCORM file (Articulate Rise link): Health & Safety

Learning Outcomes:

- Understand occupational-safety principles and environmental risk management.
- Identify workplace hazards and recommend preventive measures.
- Demonstrate proper response during simulated emergencies.
- Promote leadership and communication for promoting safe behaviour.

Trainee / Trainer Qualification Requirements:

No specific technical background is required. Participants should have prior experience in industrial or laboratory environments and a general understanding of workplace safety principles.

Training Content Developers / Educators:

Researcher Evangelia Mylona (NTUA), Dr. George Valakas (NTUA), Dr. Alexandros Banis, Em. Prof. Katerina Adam (NTUA)

SkiComCu – Soft Skills

This cross-cutting module builds interpersonal and managerial skills essential for effective communication, leadership, teamwork, and inclusion in technical workplaces. It complements technical competence with professional behaviour aligned with lifelong-learning and diversity objectives.

SCORM file (Articulate Rise link): Soft Skills

Learning Outcomes:

- Understand the importance of effective communication.
- Identify various communication techniques and approaches.
- Develop and promote a teamworking environment.

Trainee / Trainer Qualification Requirements:

No technical prerequisites are required. Participants are encouraged to have prior work experience in teams or industrial settings to contextualize communication, leadership, and collaboration.

Training Content Developers / Educators:

Dr. Vasilis Loukadakis (NTUA), Prof. Spyros Papaefthymiou (NTUA)

Training Modules Structure

The training structure and duration of the five modules are outlined in the following table. Level A, corresponding to EQF Levels 6-8, is intended for senior and middle managers, office personnel, and HR personnel. Level B, corresponding to EQF Levels 3-4, is aimed at technical and labor-position personnel. The duration for in-person/live-online delivery refers to the initial planning during the development of the materials, before they were converted into the asynchronous format.

No	Module	Trainee Level	Lessons	Module Sections	Duration (hours)	
					Asynchronous (Online: Learning Point)	Synchronous (in-person/live-online)
1	Supply Chain of Copper	A	12	7	10	20
		B	8[1]	5	8	12
2	Extractive Waste Management	A	23	5	8	12
		B	9[2]	3	6	7
3	Physical metallurgy	A	31	10	10	23
		B	20[3]	8	8	11
4	Health & Safety	A & B	7	-	4	8
5	Soft Skills	A & B	24	7	3	14

[1] The asynchronous version for technical and labour-position personnel is planned for development in 2026 and will be available in English.
[2] The asynchronous version for technical and labour-position personnel is planned for development in 2026 and will be available in English.
[3] The asynchronous version for technical and labour-position personnel is planned for development in 2026 and will be available in English.

Target Group	EQF Level
Technical and Labor-Position Personnel	3-4
Mid-Managers and Office Personnel	6
Senior Managers	7-8
HR Personnel	8

Conclusions

The updated version of deliverable D3.1 demonstrates the successful development and finalisation of the SkiComCu modular training curriculum. The work addresses the sector's growing need for structured, scalable, and industry-aligned training by providing a complete set of modules, accompanied by the description of the learning outcomes, pedagogical approach, and delivery formats. The hybrid learning model, combining SCORM-based asynchronous content with interactive synchronous sessions, has proven effective in supporting both flexibility and practical application. Overall, the deliverable demonstrates substantial progress and provides a solid foundation for the continued implementation and scaling of the SkiComCu training programme.