XRGREEN.CON

Green and Digital Construction with XR Technologies

New curriculum proposal

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New Curriculum Proposal

Title: *Green and Digital Construction with XR Technologies*

Target Group: VET, university, and polytechnic teachers involved in construction, finishing, and sustainability-related education (EQF 3–5).

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Contents

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Abstract

In response to the twin challenges of climate change and rapid digitalization, the construction sector is undergoing profound transformation. However, vocational education and training (VET) programs at EQF levels 3–5 often fail to adequately address green construction practices, the use of digital tools (e.g., BIM, CAD), and the integration of immersive technologies such as Extended Reality (XR). This curriculum proposal presents a modular, XR-enhanced training model aimed at equipping VET teachers with essential green and digital competences aligned with European priorities and qualification frameworks.

The curriculum is informed by an extensive needs analysis—including a review of 56 VET programs across five EU countries, an e-survey of 62 stakeholders (teachers, companies, students), and focus groups—which revealed limited integration of sustainability and digital learning outcomes, minimal XR exposure among educators, and a strong demand for engaging, practice-oriented training tools.

To address these gaps, the curriculum adopts an active, learner-centered methodology, combining scenario-based and project-based learning with immersive XR-supported simulations and collaborative lesson planning. Implementation is designed to be flexible—accommodating onsite, blended, and remote formats—while supporting both learner development and teacher professionalization through formative and summative assessments mapped to EQF and ECVET standards.

Structured into three interlinked modules (totaling 30 hours), the program covers XR fundamentals, the design and facilitation of XR-based green construction learning experiences, and assessment strategies. Each module includes clear learning outcomes tailored to educators, and is supported by ready-to-use materials such as teacher guides, worksheets, and XR demonstration content.

This initiative marks a pioneering effort to embed XR technologies in sustainable construction training at the vocational level. The result is a scalable, transferable curriculum that empowers both students and teachers to lead the green and digital transition in construction.

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1. Rationale

In the face of climate goals and digital transformation, the construction sector is evolving rapidly. Yet, curricula for VET students at EQF levels 3–5 often lack structured training in green construction methods, digital tools (e.g., BIM, CAD), and immersive technologies like Extended Reality (XR)**.**

Based on:

1. curricula analysis across 5 EU countries (56 programs, 270+ courses)
2. e-survey data (62 respondents — teachers, companies, students).

Key issues were identified:

1. weak integration of green and digital learning outcomes (LOs) in current VET programs
2. lack of XR experience among teachers and XR presence in the schools
3. need for practical, engaging learning tools to motivate students and reduce on-site training risks.

This proposal responds to these needs with a modular curriculum and teacher training program that integrates green**,** digital, and XR-based teaching**.**

Innovation and Added Value

This curriculum introduces key innovations that go beyond traditional VET training:

1. **first integrated curriculum** combining **XR technologies**, **sustainability**, and **pedagogy** in the construction sector
2. **supports cross-sector collaboration** - builds bridges between VET institutions, technology developers, and construction companies
3. **promotes digital equity** - addresses disparities in teacher readiness, digital skills, and access to immersive learning tools in underserved regions
4. **portable and scalable across EU contexts** - modular design and open-access resources enable replication and adaptation across different countries, levels, and professions.

Supporting Data (Summary)

From *Joint Curricula Analysis*, *E-Survey and Focus-groups results*:

1. 70% of surveyed teachers had no XR experience but high interest
2. Companies cite potential in safety training, visualization, and efficiency

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3. Students prefer visual and simulation-based learning for risky tasks;
4. Existing LOs in EQF 3–5 lack concreteness in green/digital domains.

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2. Objectives, learning and assessment approaches

Objectives

General Objective:

To develop a modular curriculum enhanced with XR technology that empowers vocational school teachers to apply innovative pedagogical approaches in teaching circular economy and sustainability in construction, while simultaneously strengthening green and digital competences among technical students.

Specific Objectives:

1. Introduce XR technologies as a teaching and learning method in VET;
2. Develop green competences related to sustainable building, waste reduction, and energy efficiency;
3. Improve teachers' capacity to deliver digital and XR-integrated lessons;
4. Align learning outcomes with EQF 3–5, ECVET standards and EU Green Deal & Digital Education Action Plan;
5. Ensure practical applicability of ~~k~~knowledge and skills through field-tested methods;
6. Strengthen VET teachers' ability to apply XR-based digital methods and immersive pedagogical approaches to effectively teach topics related to sustainable construction.
7. Create a transferable curriculum model across EU countries.

Methodology and Teaching Approach

1. **Learner-centered, active learning approach** - The curriculum places students at the center of the learning process, encouraging participation, critical thinking, and autonomy in practical and theoretical tasks.
2. **Scenario-based and project-based learning -** Learners engage with real-world construction situations and sustainability challenges through simulated tasks and problem-solving projects.
3. **XR-supported visualization, simulation, and role-play -** Extended Reality (XR) provides a safe, immersive environment where learners can explore, design, and test construction tasks virtually—enhancing spatial awareness and decision-making.
4. Peer review and collaborative lesson planning (for teachers) **-** Teachers participate in collaborative planning sessions to design XR-supported lessons, and receive constructive feedback from colleagues to improve practice and share innovation.

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5. Mixed delivery formats: onsite, blended, remote - The curriculum is flexible and adaptable, allowing implementation in various teaching contexts—traditional classrooms, hybrid models, and remote training environments.

Evaluation and Assessment Strategy

The curriculum includes a comprehensive and structured approach to learner evaluation and teacher certification:

1. Formative assessments (self-reflection, peer review, task-based) - Continuous assessment fosters active learning, self-regulation, and collaboration.
2. Summative assessments (performance tasks, digital simulations) - Competence demonstration through practical, scenario-based tasks ensures job relevance.
3. Learning Outcome (LO) mapping to ECVET and EQF descriptors - Each module includes explicit alignment to facilitate credit transfer and recognition across the EU.
4. Optional micro-credential system for teacher certification - Certified participation in XR-based pedagogy can be documented through digital badges or ECVET-compatible certificates.

Target Audience

1. Primary: VET teachers in the construction field, as well as university and polytechnic teachers delivering practice-oriented construction and sustainability-related courses
2. Secondary: School curriculum developers, sector trainers, policy implementers.

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3. Program Structure and Module Overview

To provide a clear overview of the programme's goals, this chapter begins with the general learning outcomes that apply to the full XRGreen.Con curriculum. These outcomes reflect what educators are expected to know, understand, and be able to do upon successful completion of all three modules. The specific learning outcomes for each module are presented within the corresponding module descriptions.

General Learning Outcomes of the XRGreen.Con Curriculum – upon completion of the training programme, participants will be able to:

1. Understand the potential and limitations of XR technologies in sustainable construction education.
2. Integrate green construction principles and circular economy concepts into XR-supported teaching.
3. Design and deliver inclusive and experientially rich XR-based learning activities that actively engage learners.
4. Select appropriate XR tools and apply them effectively to vocational training contexts.
5. Assess learning using digital and immersive methods, aligned with sustainability competencies.
6. Collaborate with peers to co-create and refine innovative training scenarios using XR.
7. Apply ethical and copyright principles in the use and creation of XR content.

All learning outcomes are structured using EQF descriptors and follow the Knowledge–Skills–Attitudes (KSA) model. The KSA model stands for Knowledge, Skills, and Attitudes. It is a framework used in education and training to define and assess what learners should:

1. Know (Knowledge);
2. Be able to do (Skills);
3. Value or demonstrate (Attitudes).

The KSA model helps design learning outcomes that promote not only understanding but also practical application and mindset development.

The proposed curriculum consists of three standalone but interlinked modules (total: 30 hours). Each includes learning outcomes (LOs), learning units, teaching methods, assessment methods, and assessment tools — for example, flashcards as a tool for self-assessment or retrieval practice.

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Module Overview and Structure

The following sections present the structure of the three modules included in this program. For each module, a detailed table outlines the learning outcomes, learning units, module objectives/thematic blocks, lesson topics, assessment methods, methodological support, and estimated lesson hours. Each learning outcome is clearly linked to specific thematic blocks and activities to ensure a focused, coherent, and progressive learning experience across all modules. This structure supports a blended learning approach, combining both theoretical foundations and practical application, culminating in reflective practice.

EQF level: 3-5 (intermediate to advanced vocational/professional competence—adjustable based on target learners)

Associated ECVET points: 1 ECVET

Modules:

Module	Title	Learning Outcomes Summary	Duration
1	***XR in Construction Education: Technologies and Pedagogical Approaches***	XR basics, green construction, digital awareness	5h
2	***Creating and Implementing XR Learning Scenarios for Sustainable Construction***	XR use on site, circular economy, virtual simulation	30h
3	***Effective Use of XR in Education: Implementation and Evaluation***	Didactic design, immersive learning strategies, digital inclusion	5h

The detailed structure of each module, including specific learning outcomes, thematic blocks, lesson topics, and assessment methods, is further elaborated in the respective module descriptions below.

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Module 1: *XR in construction education: technologies and pedagogical approaches*

Duration: 5 hours

Module Abstract: This module focuses on the use of XR technologies (Augmented, Virtual, Mixed, and Extended Reality) in the context of sustainable construction and vocational education. The aim is to provide a theoretical foundation to understand XR opportunities, challenges, and their role in green transition in the construction sector, as well as to develop pedagogical insights for XR-supported learning.

General module objectives are:

1. provide foundational knowledge of XR technologies and their relevance to sustainable construction
2. develop understanding of sustainability principles and their integration with digital tools in construction education
3. introduce pedagogical frameworks and instructional design models tailored for XR-supported learning
4. prepare participants for practical XR applications and reflective learning in subsequent modules
5. evaluate usability and learner needs prior to XR module development
6. select and operate XR tools that support sustainability-focused learning goals
7. define and apply quality criteria for XR learning experiences addressing construction challenges.

The main thematic blocks running through this module are:

1. fundamentals of XR technology and sustainability concepts
2. digital tools and green innovation in construction using AR technologies
3. using VR technology in construction training and sustainable practice simulation
4. integrating MR in vocational education – combining digital and real-world elements
5. sustainability strategies and their leverage through XR technologies
6. pedagogical approaches and instructional design for XR-enhanced education

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1. XR in construction education: technologies and pedagogical approaches

No.	Learning Unit	Module Objective / Thematic Block	Learning Outcome	Teaching Methods	Assessment Methods	Assessment Tools	Methodological Support
1	XR technology fundamentals	**Fundamentals of XR technology and sustainability concepts**	*Distinguish between XR, AR, VR, and MR technologies and their relevance to sustainable construction.*	Dynamic e-learning content, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Online forum facilitation + feedback/Q&A sessions
2	AR applications in construction	**Digital tools and green innovation in construction using AR technologies**	*Able to identify opportunities and limitations of AR use in green construction.* *Evaluate AR tools and technologies applicable to vocational education in the construction sector.*	Dynamic e-learning content, recorded video, interactive activities.	Online quizzes, group presentations, SWOT analysis.	LMS quizzes, interactive exercises, AR demonstrations.	Online forum facilitation, feedback, expert Q&A sessions.
3	VR applications in construction	**Using VR technology in construction training and sustainable**	*Able to analyze the potential of VR in safety, design, and energy efficiency.* *Apply VR tools to simulate green construction*	VR simulations, online demonstrations, practical VR assignments.	Practical task assessment, VR project presentations.	VR skill checklists, video assessments, reflection forms.	Access to VR platforms, technical support, online guidance.

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		practice simulation	*processes in vocational training.*				
4	MR applications in construction	**Integrating MR in vocational education – combining digital and real-world elements**	*Able to evaluate the benefits of MR in real construction scenarios.* *Develop skills to integrate MR solutions into teaching and work processes.*	Online sessions, interactive MR exercises.	SWOT analysis, group presentations, discussions on MR applications.	Presentation recordings, MR activity videos, reflection sheets.	Online forums, case study materials, expert support.
5	Sustainability strategies and how they can be leveraged by XR	**Sustainability strategies and their leverage through XR technologies**	*Critically engage with sustainable development strategies relevant to the construction industry and XR integration. SDGs; green skill frameworks (e.g. GreenComp); integration into XR learning.*	Dynamic e-learning content, recorded video, online quizzes, interactive activities	Online quizzes, exercises submitted online	LMS quizzes, interactive knowledge check exercises.	Online forum facilitation + feedback/Q&A sessions
6	XR pedagogy	**Pedagogical approaches and instructional design for XR-enhanced education**	*Analyze key pedagogical theories and their relevance in XR-supported teaching environments. Apply instructional design models (e.g.* ADDIE, SAM, XR-specific design models*) to create XR*	Dynamic e-learning content, recorded video, online quizzes, interactive activities	Concept maps uploaded online, online quizzes;	LMS quizzes, interactive knowledge check exercises. Digital concept maps;	Online forum facilitation + feedback/Q&A sessions

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			learning scenarios aligned with construction and sustainability goals.				

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Module 2: Creating and implementing XR learning scenarios for sustainable construction

Duration: 30 hours

Module Abstract: Module 2 focuses on the practical creation and implementation of XR learning scenarios targeted at sustainable construction. Participants will develop skills in evaluating usability, selecting appropriate XR tools, designing quality content, and iteratively improving XR-based educational modules. This module bridges theoretical knowledge with hands-on XR design and development practices.

General module objectives are:

1. design and prototype inclusive and sustainable XR training scenarios aligned with quality standards and green construction competencies
2. apply AR, VR, and Gen AI tools to plan, create, and produce XR learning content for sustainable construction training
3. plan, create, publish, and document XR content in compliance with copyright, ethical, and credibility standards
4. collaborate in the co-development, testing, evaluation, and iterative improvement of XR educational materials based on user feedback.

The main thematic blocks running through this module are:

1. quality and sustainability standards
2. applying AR in sustainable construction training: overlaying digital data onto real environments
3. applying VR for immersive sustainable construction training in virtual 3D environments
4. understanding how Gen AI tools and workflows can optimize tasks, automate routine processes, and improve efficiency in construction-related learning and work environments
5. structured XR scenario planning and prototyping
6. copyright and ethical content creation
7. collaborative XR scenario design and co-creation
8. enable learners to systematically document XR learning scenarios and share knowledge online with peers and educators
9. XR scenario production: 360º media and coding
10. XR scenario testing, evaluation, and iterative improvement.

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Creating and implementing XR learning scenarios for sustainable construction

No.	Learning Unit	Module Objective / Thematic Block	Learning Outcome	Teaching Methods	Assessment Methods	Assessment Tools	Methodological Support
1	Quality criteria for construction-focused XR training	**Quality and sustainability standards**	*Define quality criteria for XR learning experiences addressing safety, waste reduction, and environmental impact.*	Live streamed sessions, recorded video, online quizzes, interactive activities Online discussions; group rubric development sessions	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Online discussion forums, expert guidance
2	Scenario design in Augmented Reality (AR)	**Applying AR in sustainable construction training: overlaying digital data onto real environments**	*Design AR-based learning scenarios aligned with key green construction competencies*	Live-streamed sessions with AR demonstrations; recorded videos; online quizzes; interactive AR activities	Online quizzes; practical discussions; evaluation of AR scenario prototypes	LMS quizzes; interactive knowledge checks; AR content submissions (screenshots/screencasts)	Collaboration platforms; expert feedback; AR design templates and guidelines
3	Scenario design in Virtual Reality (VR)	**Applying VR for immersive sustainable construction training in virtual 3D environments**	*Design VR-based immersive scenarios aligned with green construction competencies*	Live-streamed VR demos; recorded explanations; online quizzes; interactive VR simulation activities	Online quizzes; practical discussions; evaluation of VR scenario prototypes	LMS quizzes; VR simulation submissions (video captures); peer review tasks	Collaboration platforms; expert feedback from VR specialists; VR scenario templates

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4.	Making the process more efficient with Gen AI	**Understanding how Gen AI tools and workflows can optimize tasks, automate routine processes, and improve efficiency in construction-related learning and work environments**	*Learners are able to identify use cases and design simple Gen AI–supported workflows that increase efficiency, accuracy, and sustainability in their tasks*	Live-streamed demonstrations of Gen AI tools; recorded video tutorials; practical online exercises; interactive activities with AI prompts	Online quizzes; practical discussions; evaluation of a simple Gen AI efficiency-improvement workflow	LMS quizzes; Gen AI workflow submissions (text, screenshots, or short videos); interactive knowledge checks	Collaboration platforms; expert feedback; Gen AI usage guidelines; prompt templates and best practice examples
5	Storyboarding and prototyping XR modules	**Structured XR scenario planning and prototyping**	*Develop storyboards and functional prototypes incorporating circular economy and accessibility principles.*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Mentored workshops, online tutorials
6	Digital content ethics and sharing	**Copyright and ethical content creation**	*Plan, create, and publish XR educational content with proper copyright and source evaluation.*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Online databases, expert consultation
7	Co-developing XR training scenarios	**Collaborative XR scenario design and co-creation**	*Develop and test XR learning modules aligned with green construction competencies.*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Templates for XR scenario planning User-testing checklist

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							Sample peer review forms
8	XR scenario documentation and knowledge sharing	**Enable learners to systematically document XR learning scenarios and share knowledge online with peers and educators**	*Learners can create, share, and refine XR scenario documentation; apply peer feedback to improve scenarios*	Live streamed webinars; recorded tutorials; online collaborative workshops (Miro, Teams, Google Workspace); discussion forums; interactive assignments	Submission of XR scenario documentation; peer and mentor feedback evaluation; participation in discussion forums; reflective logs	LMS submission portal; collaborative platforms (Google Docs, Miro); online peer review rubric; reflection templates	Online guides and templates; sample documented XR scenarios; expert Q&A sessions; access to collaborative platforms
9	XR content production 360º & coding	**XR scenario production: 360º media and coding**	*Plan and carry out XR content creation, including location scouting, equipment familiarity, and filming.*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Practical sessions
10	Testing and iterative improvement	**XR scenario testing, evaluation and iterative improvement**	Test and improve XR learning modules using learner and peer feedback to enhance quality and effectiveness.	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Mentored evaluation workshops

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Module 3: *Effective use of XR in education: implementation and evaluation*

Duration: 5 hours

Module Abstract: This module focuses on the effective use of XR technologies in educational settings, particularly within sustainable construction. It provides practical guidance and methods for facilitating XR-based learning activities, as well as tools for reflection and evaluation of the learning process. The module encourages the collection and analysis of feedback to continuously improve the content and approach, thereby strengthening professionals' competence in XR-supported learning environments.

General module objectives are:

1. integrate XR effectively into existing training curricula and courses
2. manage classroom logistics and technical setups for XR
3. facilitate XR experiences promoting sustainable operational practices
4. evaluate learner performance within XR environments.

The main thematic blocks running through this module are:

1. facilitation of XR lessons in vocational and adult education contexts
2. practical management of XR technology for sustainable construction topics
3. reflective practices and assessment of immersive learning experiences
4. collaborative development and iterative improvement of XR educational content.

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Effective use of XR in education: implementation and evaluation

No.	Learning Unit	Module Objective / Thematic Block	Learning Outcome	Teaching Methods	Assessment Methods	Assessment Tools	Methodological Support
1	Curriculum integration of XR	**Facilitation of XR lessons in vocational and adult education contexts**	*Integrate XR effectively into existing training curricula and courses*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Facilitator guides; example curriculum models
2	Technical management of XR	**Practical management of XR technology for sustainable construction topics**	*Manage classroom logistics and technical setups for XR*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Technical manuals; video tutorials
3	Facilitation of XR lessons	**Facilitation of XR lessons in vocational and adult education contexts**	*Facilitate XR experiences promoting sustainable operational practices*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Session recordings; mentor support
4	Assessment and reflection	**Reflective practices and assessment of immersive learning experiences**	*Evaluate learner performance within XR environments*	Live streamed sessions, recorded video, online quizzes, interactive activities	Online quizzes, practical discussions.	LMS quizzes, interactive knowledge check exercises.	Assessment guidelines; exemplary case studies

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4. Implementation Plan

A comprehensive implementation plan has been developed to ensure effective adaptation, training, and piloting of the modules within vocational education settings. The plan encompasses several phases—from curriculum localization and teacher training to real-world piloting, evaluation, and final dissemination of results. The table below outlines the key activities and descriptions for each phase. Plan:

Phase	Activities	Description
I	Curriculum localization and translation	Modules and teaching materials will be adapted linguistically and contextually for use in each partner country.
II	VET teacher training (workshops, XR labs)	Teachers will participate in the development and testing of XR-based learning modules aligned with green construction competencies. This includes collaborative scenario design, prototyping, and iterative improvement. In addition, they will receive hands-on training in XR tools, sustainability content, and digital pedagogies through interactive workshops and XR lab sessions.
III	Piloting in 3–5 vocational schools	Selected institutions will test the modules in real classroom settings with students and provide structured feedback.
IV	Evaluation and refinement	Based on pilot outcomes, materials and methods will be adjusted to improve clarity, usability, and effectiveness.
V	Final publication and dissemination	All results are made available via the Erasmus+ Project Results Platform (E+PRP – the official EU platform for sharing Erasmus+ project outcomes).

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5. Alignment with EU and National Frameworks

The curriculum is strategically designed to align with European and national priorities in vocational education and training (VET). It ensures coherence with recognized frameworks and policy directions, supporting both international recognition and local relevance. Key alignment aspects include the following:

1. **fully aligned with EQF Levels 3–5** - learning outcomes and competence levels follow European Qualification Framework standards for technician-level education
2. **designed for ECVET and ECTS transferability** - the modular structure and credit system support international mobility and recognition of learning achievements across VET systems
3. **supports EU Green Deal, Digital Education Action Plan, and Resilience & Recovery goals** - content addresses priorities such as environmental sustainability, digital innovation, and economic recovery through workforce upskilling
4. **complies with VET reform directions in Latvia and other EU countries** - the proposal aligns with national strategies aiming to modernize vocational education and enhance teacher competences in digital and green sectors.

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6. Support Materials

To support teachers and educational institutions in the effective implementation of the curriculum, a variety of practical resources and tools have been developed. These materials facilitate lesson planning, enhance learner engagement, and ensure alignment with educational standards, while offering accessible solutions for diverse teaching contexts.

Practical Resources for effective teaching:

1. **presentation slides, worksheets, and digital assets** – ready-to-use teaching aids that save time and support effective content delivery in hybrid or digital classrooms
2. **online tutorials and screencasts** – short, focused videos for teachers and learners explaining XR tools, green construction concepts, and digital pedagogical strategies
3. **templates for learning outcome mapping, assessment, and lesson design** – editable formats to align content with EQF standards, structure evaluation, and streamline lesson planning
4. **XR demo files and low-cost app suggestions** – sample XR materials and affordable technology options to ensure accessibility across diverse institutional settings
5. **interactive learning resources and quizzes** – tools to reinforce learner engagement, check understanding, and promote active participation
6. **teacher support manuals and methodological guidelines** – practical documents that guide educators in applying XR technologies effectively and confidently
7. **access to online support platforms or peer forums** – digital spaces for educators to exchange experiences, seek assistance, and collaborate across institutions
8. **best practice examples and case studies** – real-life use cases that demonstrate XR integration in VET and adult education, inspiring practical adoption.

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