Alliance4XR

Innovation alliance to infuse Extended Reality skills into Higher education and Vocational Training

D2.1 Co-design of the Alliance4XRteaching and training material

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Abstract (for dissemination)	*This report presents the findings of Task 2.1 of the Alliance4XR project, which focuses on the co-design of teaching and training curricula for Extended Reality (XR) technologies. The aim of this task was to collaboratively develop a competency-based curriculum framework that integrates digital and green skills while aligning with European educational standards (EQF, ECVET, EQAVET). The report documents the international focus group workshop, which brought together higher education institutions, vocational training providers, industry experts, and policymakers to define learning outcomes, curriculum structure, and assessment strategies.* *A participatory co-design methodology was employed, drawing on collaborative curriculum design models and stakeholder engagement strategies. The workshop utilised interactive tools such as Miro, Mentimeter, and hybrid conferencing (OWL 3) to facilitate meaningful contributions from both in-person and online participants. The outcome of this process was a modular, industry-aligned curriculum designed to support students and educators in acquiring the necessary technical, ethical, and sustainability-focused competencies for the evolving XR landscape.*

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Abbreviations

Term	Explanation
XR	Extended Reality
HEI	Higher Education Institutions
VET	Vocational Education and Training
VR	Virtual Reality
AR	Augmented Reality
MR	Mixed Reality

IAR	Intelligent Augmented Reality
GenAI	Generative Artificial Intelligence
Alliance4XR	Alliance for Extended Reality
EU	European Union
QB	Quality Board
CCD	Collaborative Curriculum Design
UDL	Universal Design for Learning

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EXECUTIVE SUMMARY

This report outlines the outcomes of Task 2.1 within Work Package 2 of the Alliance4XR project, focusing on the co-design of teaching and training curricula for Extended Reality (XR) technologies. The objective was to collaboratively develop a competency-based curriculum framework that integrates digital and green skills while aligning with European educational standards (EQF, ECVET, and EQAVET).

An international focus group workshop served as the primary forum for co-design, bringing together higher education institutions, vocational training providers, industry experts, and policymakers. The workshop employed a participatory co-design methodology, using interactive tools such as Miro, Mentimeter, and OWL 3 hybrid conferencing to enable contributions from both in-person and online participants. The outcome was a modular, industry-aligned curriculum designed to equip students and educators with essential technical, ethical, and sustainability-focused competencies required in the evolving XR landscape.

The co-designed curriculum provides a structured framework for both student and educator training, embedding ethical considerations across all strands rather than treating them as a standalone unit. The report also defines Key Performance Indicators (KPIs) developed collaboratively to measure curriculum effectiveness during the pilot implementation phase, focusing on learner engagement, skill acquisition, platform usability, and industry relevance.

While the draft curriculum establishes a strong foundation, it is acknowledged that explicit alignment with EQF levels, ECVET credit allocations, and EQAVET quality assurance processes will be further refined during the iterative design phases of Task 2.2 and Task 2.3. These subsequent tasks will involve developing detailed teaching materials, testing pilot programs, and validating learning outcomes, ensuring that the curriculum fully meets European educational standards for recognition, transferability, and workforce relevance.

Ultimately, this report highlights the value of stakeholder collaboration in bridging the gap between education and industry and sets a clear roadmap for the development, implementation, and continuous enhancement of the Alliance4XR curriculum.

1 INTRODUCTION

The Alliance4XR project is an ambitious initiative funded under the Erasmus+ program, aimed at fostering innovation and bridging the digital skills gap by integrating Extended Reality (XR) technologies into higher education (HEI) and vocational education and training (VET). XR, which encompasses Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR), has emerged as a transformative tool for education and industry, offering immersive, interactive, and experiential learning opportunities. The project seeks to address the growing demand for digital and green skills in key sectors such as structural engineering, energy and grids, and the maritime sector, where XR technologies can play a pivotal role in enhancing training, safety, and operational efficiency.

The primary goal of the Alliance4XR project is to design, develop, and validate an innovative teaching and training approach that leverages XR technologies to meet the evolving needs of both education and industry. Specifically, the project aims to:

- **Enhance Digital and Green Skills:** By integrating XR into curricula, the project seeks to equip students and professionals with the digital competencies required for the modern workforce, while also promoting sustainability and green skills in line with global environmental goals.
- **Foster Collaboration Between Education and Industry:** The project emphasises the importance of collaboration between higher education institutions, vocational training centres, and industry stakeholders to ensure that training programs are aligned with real-world needs and market demands.
- **Promote Standardisation and Scalability:** Alliance4XR aims to develop standardised frameworks for XR content, tools, and assessment metrics, ensuring that XR solutions can be easily adopted and scaled across different sectors and educational contexts.
- **Address Barriers to XR Adoption**: The project identifies and addresses key challenges such as high costs, lack of training, and resistance to technology adoption, particularly among veteran professionals, by developing tailored training programs and collaborative funding models.
- **Support Remote and Hybrid Learning**: In response to the global shift towards remote and hybrid work and learning environments, the project

focuses on creating flexible XR solutions that can be accessed and utilised in diverse settings.

1.1 Stakeholders

The Alliance4XR project targets a wide range of stakeholders, including:

- **Higher Education Institutions (HEIs):** Universities and colleges that are looking to integrate XR technologies into their curricula to enhance student learning and prepare graduates for the digital economy.
- **Vocational Education and Training (VET) Centres:** Training providers that aim to equip learners with practical, job-ready skills using immersive XR tools.
- **Industry Partners:** Companies in sectors such as engineering, energy, and maritime industries that can benefit from XR technologies for training, safety simulations, and operational efficiency.
- **Research Institutions:** Organisations focused on advancing XR technologies and their applications in education and industry.
- **Public Sector Entities:** Government agencies and policymakers who can support the adoption of XR technologies through funding, policy incentives, and standardisation efforts.

The co-design of teaching and training material serves as a fundamental pillar of the Alliance4XR project, ensuring that the curricula and training programs developed are both academically robust and practically aligned with industry and labour market demands. This collaborative approach brings together stakeholders from education, industry, and research, fostering a dynamic exchange of expertise and perspectives. By actively engaging these diverse contributors, the project guarantees that the educational material remains relevant to the specific needs of different sectors, equipping learners with skills that are directly applicable in their professional environments.

Beyond relevance, the curriculum embraces innovation by integrating the latest advancements in XR technology, crafting immersive and engaging learning experiences that reflect cutting-edge industry trends. The initiative also prioritises inclusivity, designing XR solutions that cater to a diverse range of learners, including individuals from non-English speaking backgrounds, and those with additional educational needs (AEN). By ensuring accessibility and adaptability, the project broadens opportunities for participation in XR-based education and

training. Furthermore, the program is committed to sustainability, embedding green skills and environmentally conscious practices within XR training strands. Through this approach, the project not only addresses immediate workforce needs but also contributes to global efforts in tackling environmental challenges, reinforcing the role of XR as a transformative force in education and industry.

The co-design process also fosters a sense of ownership and commitment among stakeholders, ensuring that the developed materials are widely adopted and effectively implemented. By bringing together diverse perspectives, the project creates a robust ecosystem for XR innovation, where knowledge flows seamlessly

1.2 Objectives of Task 2.1

Task 2.1, titled "Co-design of the Alliance4XR Teaching and Training Material" is a critical component of Work Package 2 (WP2) within the Alliance4XR project. This task focuses on the collaborative development of teaching and training curricula that leverage Extended Reality (XR) technologies to address the identified needs and challenges in higher education (HEI) and vocational education and training (VET). The specific objectives of Task 2.1 are as follows:

1. **Co-Design of Curricula**

   The development of teaching and training curricula within the Alliance4XR project is centred on a collaborative co-design process, ensuring that the materials created are both academically rigorous and aligned with the evolving needs of industries such as engineering, energy, and maritime. By engaging stakeholders from education, industry, and research, the project fosters a participatory approach that guarantees practical relevance and real-world applicability.

   The co-design process incorporates a workshop, focus groups, and iterative feedback loops, allowing for continuous refinement and validation of the curricula. The outcome of this collaborative effort is a comprehensive curriculum that equips learners with the knowledge, skills, and competencies essential for effective XR technology use in targeted sectors.

2. **Alignment with European Standards**

   To ensure broad applicability and recognition, the co-designed teaching and training materials have been structured in accordance with established European educational frameworks, including EQF, ECVET, and EQAVET. By adhering to these standards, the curriculum guarantees consistency and

transferability across different European countries and educational systems. This alignment further facilitates the certification of XR-based skills and competencies, making it easier for learners to transition into the workforce with qualifications that are widely recognised.

The structured approach ensures that the curriculum is not only academically robust but also provides learners with practical, standardised training experiences that meet the demands of both vocational and higher education institutions.

3. **Development of Key Performance Indicators (KPIs) for Pilot Implementation**

   A critical aspect of the Alliance4XR project is the development of measurable KPIs to assess the effectiveness of the curriculum during the pilot phase. These indicators, formulated in collaboration with stakeholders, focus on evaluating learner engagement, skill acquisition, technological usability, and overall satisfaction.

   By defining clear and relevant KPIs, the pilot implementation will provide actionable insights into how well the curriculum meets learning objectives and industry expectations. These metrics will be instrumental in refining and improving the teaching and training materials for wider adoption.

4. **Facilitation of Knowledge Flow and Collaboration**

   The success of the co-design process is heavily reliant on collaboration and knowledge exchange among key stakeholders. To achieve this, the project has established a structured framework for engagement, incorporating focus groups and workshops that bring together representatives from higher education institutions, vocational training centres, industry, and research organisations.

   This participatory approach fosters an environment of shared learning, where leading practices, challenges, and innovative solutions can be openly discussed. The outcome is a more robust and adaptable curriculum that reflects the collective expertise and insights of all contributors.

5. **Integration of Digital and Green Skills**

   A key objective of the Alliance4XR project is to ensure that the curriculum integrates both digital and green skills, reinforcing sustainability as a core component of XR education. The training material includes strands and practical training scenarios that emphasise the use of XR technologies to

promote sustainable practices and environmentally conscious engineering methods.

By embedding sustainability within digital training, the curriculum prepares learners to contribute to a greener economy while enhancing their technological competencies.

6. **Preparation for Pilot Implementation**

   To ensure the seamless transition from development to real-world application, the curriculum undergoes a finalisation phase that integrates feedback from the co-design process. This includes refining the content, tools, and platform requirements to ensure that the teaching and training material is fully prepared for deployment in pilot programs.

   Through rigorous testing and evaluation, the curriculum is optimised to meet the needs of its target audience, providing a fully developed and pilot-ready educational framework for XR training.

Task 2.1 of the Alliance4XR project lays the foundation for the successful integration of XR technologies into education and industry training programs. By focusing on co-design, alignment with European standards, and the development of clear KPIs, this initiative ensures that the teaching and training materials developed are both innovative and practical.

It is important to clarify that Task 2.1 focuses on the co-design of the curriculum framework, including the definition of learning outcomes, strand structures, and alignment with European qualifications frameworks. Task 2.1 does not involve the development of detailed teaching materials, lesson plans, or instructional content—these will be addressed in Task 2.2, which will build on the foundation laid by this report.

The collaborative methodology not only enhances the quality and relevance of the curriculum but also fosters stakeholder engagement and long-term commitment. This approach paves the way for the successful pilot implementation and future scalability of XR-based training solutions, setting a precedent for immersive education and workforce development across Europe.

1.3 Workshop Overview

The Alliance4XR International Focus Group Workshop, titled *The Future of Education - XR Curriculum Co-Creation*, took place on January 16, 2025, in a hybrid

format, with in-person participation hosted at University College Dublin (UCD) and online attendance via Zoom**.**

Participants and Organisations Involved

The workshop gathered over 30 participants representing a diverse range of institutions, including universities, vocational training organisations, government bodies, private sector representatives, and educational technology experts. Key attendees included:

- Higher Education Institutions (HEIs): University College Dublin (UCD), Technological University of the Shannon (TUS), South East Technological University (SETU), Munster Technological University (MTU), University of Minho, Trinity College Dublin (TCD), Politecnico di Milano, Università Cattolica del Sacro Cuore.
- Vocational Training and Secondary Education: APRO Formasione, IS Federica, Directorate of Secondary Education of Western Thessaloniki, St Paul's Secondary School, St. Olaf's National School, Greystones Community College, Laois Offaly Education and Training Board.
- Industry and Research Organisations: Cyprus Marine and Maritime Institute (CMMI), SupportSquare, Wodo Network, Virtual Solutions, AnotheReality.
- Government and Policy Representatives: European Commission, Ministry of Education Slovenia, Ministry of Education Cyprus.

Workshop Structure and Sessions

The workshop was structured into four interactive sessions, each designed to address a critical aspect of curriculum co-design. The format combined presentations, discussions, brainstorming activities, and live demonstrations with registered participants contributing to the show and tell session scheduled for session 3.

Session 1: Presentation of WP1 Results

Session 2: Co-Design of Curriculum Structure

Session 3: Show and Tell of Existing Curriculum and Methods

Session 4: Defining Platform Tools and KPIs

2 METHODOLOGY

The Alliance4XR XR Curriculum Co-Creation Workshop was designed as a structured and participatory event aimed at developing teaching and training materials that integrate research-based insights, stakeholder expertise, and leading practices in XR education. Conducted in a hybrid format, the workshop allowed participants to join both in person at University College Dublin (UCD) and remotely via Zoom (Sanders & Stappers, 2014). The participatory nature of the workshop ensured that the diverse experiences and insights of attendees shaped the development of the curriculum.

The approach was grounded in co-creation principles, fostering collaboration among academics, industry professionals, educational policymakers, and vocational training experts (Wenger, 1998). To maintain alignment with European standards (EQF, ECVET, EQAVET), the curriculum was structured for broad applicability across various educational and professional settings (Laurillard, 2012). Inclusivity was further reinforced through a Universal Design for Learning (UDL) framework, allowing participants with varying levels of expertise and backgrounds to contribute effectively.

A key feature of the workshop was the use of scoping stimulus materials provided by Aristotle University, which included two distinct curriculum outlines—one for students and one for educators. This bifurcated approach allowed for deeper discussions rather than surface-level engagement, ensuring that both perspectives were fully explored.

It is important to clarify that Task 2.1 focuses on the co-design of the curriculum framework, including the definition of learning outcomes, strand sequencing, and alignment with European qualifications frameworks. Task 2.1 does not involve the development of detailed teaching materials, lesson plans, or instructional content these will be addressed in Task 2.2, which will build on the foundation laid by this report.

2.1 Collaborative Curriculum Design

The co-design methodology used in Task 2.1 was grounded in participatory curriculum development principles, emphasising collaborative curriculum design and stakeholder-driven decision-making (Laurillard, 2013; Salmon, 2013). This approach ensures that the curriculum reflects the needs and expectations of

higher education institutions, vocational training providers, industry partners, and policymakers, fostering alignment between educational content and real-world applications (Wenger, 1998).

Collaborative curriculum design (CCD) is a structured process in which educators, researchers, and industry professionals work together to co-develop educational content (Voogt et al., 2019). This model enables institutions to build shared ownership of learning materials while enhancing interdisciplinary cooperation and pedagogical expertise (Binkley et al., 2012). In the context of Alliance4XR, CCD was implemented through the following;

- multi-stakeholder workshops, where educators and industry representatives co-defined competencies and learning outcomes;
- iterative feedback loops, incorporating real-time input using digital collaboration tools such as Miro and Mentimeter;
- hybrid engagement strategies, ensuring inclusivity across in-person and online participants using OWL 3 hybrid conferencing technology.

This approach ensured that the curriculum design process remained dynamic and adaptable, allowing stakeholders to reflect on existing educational gaps while embedding emerging trends in XR technology into the framework (Tondeur et al., 2019).

Co-design is a participatory research approach that emphasises active collaboration between educators, students, and industry experts in the design of educational resources (McKenney & Reeves, 2012). It differs from traditional top-down curriculum development by placing stakeholder engagement at the centre of decision-making (Doll, 2013). In Alliance4XR, co-design was used to identify real-world challenges in the implementation of XR technologies across sectors such as including structural engineering, energy and grids, and maritime industries. Co-design also ensured curriculum flexibility, enabling the adaptation of strands based on regional industry needs and promoted knowledge sharing, fostering continuous input from both educators and practitioners.

A key feature of this methodology was its alignment with Universal Design for Learning (UDL) principles, ensuring accessibility and adaptability in XR training (Meyer et al., 2014). This was particularly critical for embedding ethical considerations, data privacy, and sustainability practices across all modules (Beetham & Sharpe, 2013).

2.2 Workshop Structure

The workshop was organised into four sessions, each employing different participatory techniques to maximise engagement and collaboration.

Session 1: Presentation of WP1 Results

The first session presented the findings from WP1, which mapped the state of digital and green skills in XR education, identified existing gaps, and explored leading practices (Redecker & Punie, 2017). Participants engaged in comparative analyses of existing XR educational programs, validated research findings, and discussed key insights. This process facilitated a consensus on the critical skill gaps that would inform the curriculum's design (Jensen & Konradsen, 2018).

Session 2: Co-definition of the Structure of the Teaching and Training Curricula

To define the structure of the XR curriculum, participants engaged in brainstorming exercises using Miro, a digital collaboration tool, to document thoughts and comments in real time. Small breakout groups discussed curriculum design across different educational levels, from higher education to vocational training. Participants compared proposed structures against existing curricula, ensuring alignment with industry needs and leading pedagogical practices (Kolmos, 2017). The session resulted in a preliminary structure, outlining key learning outcomes, strand themes, and delivery methods.

Session 3: Co-definition of Platform Tools and Requirements

This session focused on identifying the technological and pedagogical requirements for an XR-based learning platform (Cobb et al., 2019). Participants showcased existing XR education tools and platforms, followed by interactive polling via Menti.com to gather feedback on necessary platform features. An industry panel discussion explored the practical implementation of XR tools in educational settings, ensuring that the platform would be interactive, accessible, and cross-compatible (Dede, 2009).

Session 4: Co-definition of Specific KPIs for Pilot Implementation

The final session established Key Performance Indicators (KPIs) for assessing the effectiveness of the XR curriculum (Hattie, 2009). Experts led discussions on leading practices for measuring success, while participants engaged in consensus-building exercises to define measurable success indicators. A case study review of previous XR training programs helped refine the criteria for evaluating the curriculum's impact (Brown et al., 2016; Johnson et al., 2020). The use of Menti.com

facilitated the real-time collection of participant input to ensure an inclusive assessment framework.

2.3 Participant Engagement and Data Collection

The workshop attracted a diverse group of stakeholders, including two in-person groups of eight and seven participants, along with additional online attendees. Representation from academia, industry, government, and vocational education ensured a well-rounded, multi-perspective approach (Lave & Wenger, 1991). To facilitate collaboration between online and in-person participants, the OWL 3 hybrid meeting tool (Owl Labs, 2025) was employed.

Data collection methods included:

- Workshop registration captured participants professional area of expertise.
- Live discussions that were recorded and transcribed for thematic analysis.
- The use of Miro for online participants to document insights collaboratively.
- Digital recordings of all sessions to ensure accurate capture of contributions from both in-person and remote participants.
- Summary notetaking by facilitators to highlight key discussion points.
- The use of Mentimeter captured participants views on and experience with XR applications and XR platforms

(Merriam & Tisdell, 2016, Miles, Huberman, & Saldaña, 2014).

The Alliance4XR XR Curriculum Co-Creation Workshop was a collaborative, research-driven initiative that successfully integrated diverse perspectives into a standardised and adaptable curriculum. By incorporating structured participatory methods and aligning with European educational frameworks, the workshop laid a strong foundation for the pilot implementation of XR-based teaching and training curricula.

3 RESULTS

3.1 Curriculum Structure with Learning Outcomes

The co-designed curriculum provides a structured framework outlining the strands and learning outcomes required for effective XR education. However, while this report defines the curriculum structure and intended learning outcomes, it does not include the development of detailed teaching content or lesson materials, as these aspects are within the scope of Task 2.2. The next phase will translate this

framework into practical learning resources, teaching strategies, and digital tools to support implementation.

The Alliance4XR curricula for students and educators are designed to ensure competency-based, structured learning that aligns with European standards (EQF, ECVET, EQAVET). Each strand includes a technical, practical, and ethical dimension, ensuring learners not only acquire technical XR skills but also understand the ethical considerations associated with immersive technologies. The curricula is designed according to essential strands informed by the focus group workshop, and can be adapted into a module format according to the requirements of any given educational institutional.

3.2 Curriculum for Students

Strand	Learning Outcomes
Strand 1: Introduction to XR Technologies	**1.1** Define Extended Reality (XR) including but not limited to Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) and Intelligent XR (IXR) distinguish their applications. **1.2** Describe the historical development and future trends in XR technology. **1.3** Identify key hardware and software components used in XR environments. **1.4** Recognise the ethical implications of XR, including privacy concerns, health and safety risks of XR, and social implications.
Strand 2: XR Hardware and Software Setup	**2.1** Demonstrate the ability to set up, configure, and troubleshoot XR hardware (headsets, AR devices, motion tracking systems, etc.). **2.2** Compare different XR platforms and development tools (e.g. Alliance4XR, Unity, Unreal Engine, WebXR). **2.3** Apply basic programming concepts in XR environments to create interactive elements.

	2.4 Assess the privacy risks associated with data collection in XR devices and propose leading practices for responsible use.
Strand 3: XR Development for Engineering and Applied Sciences	**3.1** Utilise 3D modelling tools to create assets for XR applications. **3.2** Develop interactive XR simulations for engineering and applied science applications. **3.3** Implement real-time physics and spatial interactions within XR environments. **3.4** Analyse ethical considerations in XR engineering applications, including safety, accessibility, inclusivity in virtual spaces and the impact of GenAI.
Strand 4: Advanced XR Applications Across Industries	**4.1** Apply XR solutions to specific industry needs (including structural engineering, energy and grids, and the maritime sector). **4.2** Design scenario-based training simulations that mirror real-world job environments. **4.3** Optimise user interaction and experience design for different audiences. **4.4** Evaluate ethical challenges in industry-specific XR implementations, such as data security and digital labour rights in virtual workspaces.
Strand 5: Collaborative and Multi-User XR Environments	**5.1** Create multi-user XR experiences that support real-time interaction and collaboration. **5.2** Use networking technologies to facilitate shared virtual spaces. **5.3** Develop social XR applications that encourage effective communication and engagement. **5.4** Address cybersecurity and user safety concerns in networked XR environments.
Strand 6:	**6.1** Design and develop a fully functional XR application addressing a real-world problem.

Capstone Project – Ethical and Practical XR Solutions	**6.2** Integrate ethical frameworks into the project development process, ensuring responsible innovation including green skills. **6.3** Conduct user testing and feedback analysis to improve XR usability and accessibility. **6.4** Present findings in a professional demonstration and written report, detailing technical execution and ethical considerations.

Comprised

- Lecture-based learning: theory, ethics, case studies.
- Practical hands-on exercises: development, simulations, troubleshooting.
- Assessment and projects: capstone project, user testing, presentations

3.3 Curriculum for Educators

Strand	Learning Outcomes
Strand 1: Introduction to XR in Education	**1.1** Explore the pedagogical potential of XR technologies in education. **1.2** Compare different learning theories related to immersive learning. **1.3** Identify challenges in XR adoption for teaching and propose solutions. **1.4** Discuss ethical considerations in XR-enhanced learning including but not limited to student data privacy, inclusion, equity of access and GenAI.
Strand 2: Understanding XR Hardware and Software for Teaching	**2.1** Demonstrate setup and troubleshooting of XR classroom tools. **2.2** Evaluate platform compatibility and accessibility features. **2.3** Select appropriate XR applications for different educational settings. **2.4** Ensure ethical handling of student data and informed consent in XR learning environments.

Strand 3: Pedagogical Strategies for XR Integration	**3.1** Develop teaching and learning plans incorporating XR to enhance subject learning. **3.2** Apply active learning principles to XR-based instruction. **3.3** Assess learning outcomes in XR-enhanced lessons. **3.4** Foster inclusive and accessible learning environments in immersive education settings.
Strand 4: XR Content Creation for Educators	**4.1** Use XR authoring tools to create interactive learning materials. **4.2** Adapt existing 3D content for use in educational settings. **4.3** Implement assessment techniques for measuring student engagement in and learning through XR. **4.4** Address bias and ethical concerns in XR educational content development.
Strand 5: Evaluating and Improving XR-Enhanced Teaching	**5.1** Critically assess student engagement and learning effectiveness in XR lessons. **5.2** Collect and analyse student feedback to improve XR teaching methodologies. **5.3** Reflect on ethical responsibilities in immersive teaching, including green skills, content moderation and age-appropriate design. **5.4** Design an XR-enhanced teaching strand and present it to peers for evaluation.

Comprised:

- Lecture-based learning: theory, ethical frameworks, pedagogy.
- Practical workshops: hands-on use of XR tools, curriculum integration.
- Assessment and peer feedback: lesson planning, self-evaluation.

3.4 Alignment with European Standards (EQF, ECVET, EQAVET)

This initial draft of the Alliance4XR curriculum provides a strong foundation for achieving full alignment with the European Qualifications Frameworks (EQF, ECVET, and EQAVET). It outlines clear learning outcomes, modular structures, and industry-relevant competencies, which are essential starting points for developing a structured, competency-based curriculum. The integration of digital and green skills across modules, alongside the inclusion of ethical considerations, demonstrates a forward-looking approach that aligns with European priorities for vocational and higher education.

Although explicit mappings to EQF levels, ECVET credit allocations, and EQAVET quality assurance cycles are not yet fully detailed, the draft establishes the core framework upon which these elements can be systematically built. Crucially, these areas will be further developed through the iterative design process embedded in the subsequent stages of Work Package 2, specifically, Task 2.2, which focuses on the development of detailed teaching and training materials, and Task 2.3, which will involve testing, refinement, and validation of the curriculum through pilot implementations. This phased approach ensures that the curriculum will evolve based on stakeholder feedback, learner engagement data, and quality assurance insights, ultimately leading to a robust educational program that fully meets the EQF, ECVET, and EQAVET standards for recognition and transferability across Europe.

3.5 Platform Tools and Requirements

To support the XR curricula, the participants co-defined a set of platform tools and requirements that focus on scalability, accessibility, and ease of use. These include:

- **Immersive and Customisable 3D Learning Environments**: The platform should offer realistic 3D simulations for fields like engineering, medicine, and emergency training.
- **Cross-Device Compatibility**: The platform must work across multiple devices, from VR headsets (Oculus, HoloLens) to AR-enabled smartphones and standard desktop browsers.
- **Scenario and Lesson Editors**: A toolset allowing educators to create customised learning experiences based on pre-designed templates.

- **Collaborative Multi-User Environments:** Supports interdisciplinary projects and real-time interaction, crucial for collaborative learning.
- **Historical Simulations & Virtual Field Trips**: The ability to create historical explorations, museum visits, and cultural immersion experiences.
- **Low-Level Development Resources**: Training on creating high-quality XR content with accessible tools.
- **Online Collaboration Tools**: The use of online tools for idea-sharing (e.g. Miro) and for real-time polling and feedback collection (e.g. Mentimeter).

The platform should be modular, allowing for adaptation across different disciplines and education levels, making it a viable solution for higher education, vocational training, and professional development.

3.6 Key Performance Indicators (KPIs)

The focus group defined specific KPIs to assess the pilot implementation of the XR curricula. These indicators focus on learner engagement, skill acquisition, and platform usability:

1. **Engagement Metrics**
    - Number of students and educators actively using XR strands.
    - Time spent in immersive learning environments.
    - Participation in interactive discussions and hands-on projects.
2. **Learning Outcomes**
    - Improvement in technical proficiency with XR development tools.
    - Successful completion of capstone projects demonstrating real-world application.
    - Assessments on ethical considerations and leading practices in XR
3. **Platform Usability & Adoption**
    - User feedback on ease of use and accessibility.
    - Number of educators trained and their integration of XR into teaching.

- Effectiveness of support materials and tutorials for non-technical users.

4. **Industry Relevance**

- Alignment of student projects with real-world industry challenges.
- Industry partner involvement in curriculum validation and project mentoring.
- Adoption of the curriculum in vocational and higher education programs.

3.7 Stakeholder Input

Stakeholders from academia, industry, and vocational training provided valuable recommendations for refining the XR curricula and platform.

Academic Institutions

- Universities emphasised the need for structured learning pathways with clear progress markers, ensuring students acquire both foundational and advanced XR skills.
- Suggested embedding ethical considerations across all strands to ensure ongoing discussions about privacy, safety, and accessibility in XR education.

Industry Representatives

- Expressed a strong demand for industry-aligned skills, particularly practical XR development capabilities for engineering, medicine, and design.
- Highlighted the importance of scalability and flexibility, ensuring that training strands can be easily updated to keep pace with technological advancements.
- Called for more case-based learning approaches, where students solve real-world problems using XR tools.

Vocational Training Providers

- Focused on bridging the skills gap between traditional education and workplace applications of XR.
- Recommended hands-on training approaches that simulate real-world job environments to improve workforce readiness.
- Suggested more structured onboarding for students and educators unfamiliar with XR tools.

General Recommendations

- Ensure broad accessibility by designing a hybrid system that works across various devices and educational settings.
- Provide comprehensive educator support, including training videos, user manuals, and a repository of pre-built XR experiences.
- Develop a centralised library of XR learning materials and interactive models, enabling educators to easily create customised lessons.

4 DISCUSSION

4.1 Alignment with Project Goals

The Alliance4XR project is designed to bridge the digital and green skills gap by integrating Extended Reality (XR) technologies into higher education and vocational training. The co-designed curricula developed through Task 2.1 directly align with these objectives by providing structured, competency-based learning strands that equip students and educators with technical expertise in XR while embedding ethical and sustainability considerations.

One of the key aims of the project is to enhance digital and green skills, ensuring that learners acquire both technical competencies in XR development and sustainability-oriented knowledge applicable to fields such as including structural engineering, energy and grids, and the maritime industries. The curricula reflect this goal by incorporating structured learning strands that provide a balance of theoretical knowledge, hands-on applications, and real-world problem-solving. Moreover, ethical considerations have been woven throughout the curriculum, aligning with the project's commitment to responsible and inclusive digital transformation.

In addition, the project emphasises standardisation and scalability, which is why the co-designed curricula aims to align with European frameworks such as EQF, ECVET, and EQAVET. This ensures that the XR-based training is recognised across European educational institutions and industries, facilitating learner mobility and workforce readiness. The incorporation of modular learning units, competency-based assessments, and certification mechanisms further strengthens this alignment, making the curricula transferable and adaptable across multiple sectors and countries.

Finally, the project seeks to foster collaboration between education and industry, a goal that has been realised through the co-design process. The involvement of higher education institutions, vocational training centres, industry partners, and policymakers in curriculum development has ensured that the training materials remain both academically rigorous and practically relevant. By engaging multiple stakeholders, the project has built a learning ecosystem that prepares students for the evolving demands of the XR-driven economy.

4.2 Challenges and Solutions

Despite the successful co-design of curricula, several challenges emerged during the process. One of the most significant hurdles was ensuring that the curricula remained accessible and inclusive to a diverse range of learners, including those from non-technical backgrounds, non-English-speaking regions, and learners with disabilities. To address this, the project adopted a Universal Design for Learning (UDL) approach, ensuring that the curricula were adaptable to different learning needs and environments.

Another challenge was the integration of both digital and green skills into the curriculum. While many stakeholders agreed on the importance of sustainability, finding effective ways to incorporate green competencies within the curricula required significant discussions. The solution involved embedding sustainability principles within real-world XR applications, such as using XR simulations to model energy-efficient engineering practices or train maritime professionals in fuel-efficient navigation techniques. By linking curriculum content directly to environmental challenges, the structure ensures that learners gain practical sustainability insights.

The co-design process itself also presented difficulties, as stakeholders came from diverse disciplines and industries, each with different expectations and levels

of familiarity with XR technologies. To streamline collaboration, the project team implemented a structured, iterative feedback approach, using tools such as Miro and Mentimeter to capture stakeholder input in real time. This allowed for a more dynamic and adaptive curriculum development process, ensuring that all perspectives were incorporated into the final design.

Another key challenge was ensuring technological accessibility, particularly in vocational training settings where XR hardware and infrastructure may not be readily available. The solution involved designing flexible, hybrid learning pathways, where students and educators could engage with XR-related content using a range of devices, from high-end VR headsets to standard desktop computers and mobile AR applications. This hybrid model ensures that learners can still benefit from immersive educational experiences without requiring access to expensive or specialised XR hardware.

4.3 Innovation and Leading Practices

The Alliance4XR workshop and co-design process fostered several innovative approaches and leading practices that set a precedent for immersive learning development. One of the most notable innovations was the decision to embed ethical considerations within every strand rather than isolating them in a single unit. This approach ensures that responsible XR use, privacy concerns, and digital ethics remain at the forefront of learners' engagement with the technology.

A further leading practice was the use of interactive, stakeholder-driven curriculum development tools such as Miro boards for brainstorming and Mentimeter for real-time polling and feedback collection. These tools facilitated active participation from educators, industry partners, and researchers, enabling a continuous exchange of ideas and expertise.

The workshop structure itself also served as a model for collaborative, interdisciplinary curriculum design. The co-definition of KPIs as a separate workshop session ensured that the pilot implementation would be evaluated against clear, measurable criteria, including learner engagement, skill acquisition, platform usability, and industry relevance. This data-driven approach to curriculum validation represents a leading practice that can be replicated in future digital education initiatives.

Additionally, the project introduced scenario-based training simulations, allowing learners to engage with real-world challenges through XR. For example,

in engineering applications, students could test structural designs in virtual simulations, while medical trainees could practice complex surgical procedures in VR. By anchoring learning outcomes in practical, hands-on experiences, the curricula ensure that learners are job-ready and equipped with problem-solving skills.

Another innovative feature was the modular design of the curriculum, allowing for customisation and scalability. This approach enables institutions to tailor XR training programs based on their specific needs, while also allowing learners to progress through the curriculum at their own pace. The competency-based assessment model, aligned with European standards, further strengthens the scalability and transferability of the curricula.

Finally, the integration of hybrid learning environments—facilitated by OWL 3 technology for seamless remote collaboration—demonstrated how XR education can be inclusive and adaptable. The use of digital recordings and facilitator-led summary notetaking further ensured that all perspectives were captured, promoting continuous learning and improvement.

4.4 Conclusion

The co-designed curricula developed through the Alliance4XR project successfully align with the initiative's overarching goals of bridging the digital skills gap, fostering industry-education collaboration, and embedding sustainability into XR training. While the process presented challenges in accessibility, interdisciplinary collaboration, and sustainability integration, these were addressed through UDL principles, structured stakeholder engagement, and scenario-based learning.

By ensuring that the training materials are competency-driven, scalable, and industry-aligned, the project lays the foundation for a new era of digital and sustainable education, ensuring that learners are prepared for the evolving XR-driven economy.

5 RECOMMENDATIONS

The co-designed curricula developed through Task 2.1 of the Alliance4XR project provide a strong foundation for integrating XR technologies into education and vocational training. However, to ensure long-term impact, scalability, and adaptability, it is essential to establish a structured approach for curriculum

development, pilot implementation, and future updates. The following recommendations outline strategies for optimising the teaching and training material, its deployment during the pilot phase, and its iterative refinement based on stakeholder feedback.

5.1 Curriculum Development

A robust curriculum development strategy ensures that the teaching and training materials remain academically rigorous, industry-aligned, and responsive to technological advancements. To achieve this, the following key areas should be prioritised:

Content Areas

The content of the curricula should continue evolving to reflect emerging trends in XR technologies while maintaining alignment with European qualifications frameworks (EQF, ECVET, EQAVET).

- Interdisciplinary Integration: XR technologies are being rapidly adopted across multiple industries. The curriculum should incorporate case studies and real-world applications in including structural engineering, energy and grids, and the maritime sector to ensure learners develop sector-specific competencies.
- Green and Ethical Competencies: Sustainability and ethical responsibility in XR development should remain a core component of each strand, with a focus on data privacy, inclusivity, and environmental impact.
- Emerging XR Technologies: Given the fast-paced evolution of AR, VR, MR, and AI-powered XR solutions, regular updates should introduce new tools and development platforms into the curriculum to maintain industry relevance.

Delivery Methods

Ensuring accessibility and engagement across diverse learner groups requires a flexible, hybrid learning approach:

- Blended Learning Model: A combination of online and in-person sessions should be used to increase accessibility while maintaining hands-on experience in XR.
- Interactive Simulations: Scenario-based learning should be integrated into practical exercises, where students develop and test XR applications in simulated real-world environments.

- Microlearning & Modular Approach: Short, stackable learning strands should allow learners to acquire certifiable competencies at their own pace, facilitating lifelong learning and upskilling.

Quality Assurance Processes

To maintain high educational and vocational training standards, rigorous quality assurance mechanisms must be in place:

- Industry and Academic Validation: Regular consultation with industry professionals and academic institutions should be conducted to ensure that the curriculum meets labour market needs and maintains academic credibility.
- Learner Feedback Mechanisms: Continuous student and educator feedback loops should be established to refine learning outcomes and improve content clarity.
- Assessment and Accreditation: The curriculum should incorporate competency-based assessments that are aligned with ECVET credit transfer mechanisms and Bologna principles, enabling recognition across European institutions.

5.2 Pilot Implementation

To effectively implement the co-designed curriculum during the pilot phase, a structured approach must be adopted, ensuring that outcomes are measured, analysed, and refined for broader deployment.

Structured Deployment

The pilot phase should follow a phased rollout strategy, allowing for gradual refinement before full-scale implementation:

- Early Adopters: A selected group of higher education institutions, vocational training centres, and industry partners should serve as test sites for evaluating curriculum effectiveness.
- Diverse Testing Environments: The curriculum should be piloted across multiple industries and educational settings to test adaptability and applicability.
- Instructor Training: Educators and trainers should undergo structured XR pedagogy training to ensure the effective delivery of course content.

Evaluation through KPIs

A robust Key Performance Indicator (KPI) framework must be in place to assess the pilot implementation's success and areas for improvement:

- Learner Engagement and Performance: Metrics should include completion rates, engagement levels, and skill acquisition assessments.
- Platform Usability: Surveys and feedback mechanisms should evaluate the ease of use and effectiveness of the XR learning platforms.
- Industry Readiness: The relevance of skills acquired should be assessed through employer and industry feedback on learner preparedness.

Iterative Refinement During the Pilot Phase

To ensure continuous improvement throughout the pilot, data-driven adjustments should be made in real-time:

- Periodic Progress Reviews: Ongoing evaluation cycles at quarterly intervals should analyse pilot performance and identify areas needing improvement.
- Stakeholder Engagement: Continuous input from students, educators, and industry experts should be incorporated into curriculum adjustments.
- Adaptive Learning Enhancements: Based on feedback, instructional design should be fine-tuned, with improvements made to content delivery, digital tools, and practical applications.

5.3 Future Updates

For the Alliance4XR curriculum to remain relevant, an ongoing mechanism for updating and refining learning materials must be established.

Establishing a Continuous Review Cycle

A structured content revision cycle should be implemented to ensure long-term adaptability:

- Annual Curriculum Reviews: A dedicated advisory committee composed of educators, industry representatives, and policymakers should conduct annual reviews to update course content.
- Integration of New XR Technologies: Emerging tools and methodologies should be incorporated based on industry trends and academic research.
- Expansion of Learning Strands: Additional strands should be introduced to address new XR applications and sector-specific advancements.

Ongoing Stakeholder Involvement

A permanent feedback loop should be established to ensure stakeholder-driven curriculum updates:

- Educator and Student Input: Structured post-course surveys and focus groups should be conducted after every training cycle to collect feedback.
- Industry Collaboration: Partnerships with XR companies and sector-specific employers should ensure the curriculum evolves with workforce demands.
- Open Resource Sharing: Institutions piloting the curriculum should contribute to a shared repository of leading practices and instructional resources, fostering collaborative knowledge exchange.

Leveraging Data for Evidence-Based Updates

The curriculum should be continuously refined based on real-world learning data:

- Performance Tracking via Digital Learning Analytics: The use of learning management systems (LMS) and data analytics tools should help track learner progress and identify areas requiring curriculum adaptation.
- Comparison with Market Trends: Labor market insights should be incorporated to ensure alignment with evolving industry needs.
- Accreditation Updates: If necessary, certification criteria should be adjusted to remain aligned with European standards.

For the Alliance4XR curricula to remain impactful, scalable, and relevant, a structured approach to curriculum development, pilot implementation, and continuous updates must be maintained. By ensuring rigorous quality assurance, evidence-based refinements, and active industry-education collaboration, the project can provide a long-lasting framework for integrating XR technologies into vocational and higher education settings. These recommendations not only strengthen the immediate impact of the curricula but also ensure their long-term sustainability and global recognition.

6 CONCLUSION

The Alliance4XR workshop successfully brought together educators, industry professionals, and vocational training experts to co-design a curriculum that integrates Extended Reality (XR) technologies into education and workforce training. As confirmed by the post-workshop evaluation, stakeholders found the

co-design sessions highly relevant and engaging, validating the participatory approach adopted for developing the curriculum structure.

The collaborative efforts of stakeholders resulted in a structured, competency-based curriculum that can be further developed into one that aligns with European qualifications frameworks (EQF, ECVET, EQAVET) and meets the evolving needs of various industries, including structural engineering, energy and grids, and the maritime sector. Stakeholder feedback strongly supports aligning the curriculum with European qualifications frameworks (EQF, ECVET, EQAVET), underscoring the need for continued focus on standardisation and mobility in subsequent development phases.

The workshop also provided valuable insights into the challenges, innovations, and leading practices that should guide the next stages of curriculum development and implementation.

6.1 Summary of Key Points

The workshop's key findings and outcomes highlight the importance of a well-structured and adaptable curriculum that fosters digital and green skills development while ensuring inclusivity and accessibility. The co-designed curricula for students and educators integrate technical XR training with ethical considerations, sustainability principles, and industry-aligned applications.

One of the most significant achievements of the workshop was embedding ethical considerations across all learning strands rather than treating them as an isolated topic. This approach ensures that XR learners develop a critical understanding of data privacy, cybersecurity, accessibility, and environmental impact. The modular structure of the curriculum allows for flexibility in learning pathways, supporting microlearning, competency-based assessments, and interdisciplinary applications.

The pilot implementation phase will play a crucial role in evaluating the effectiveness of the curriculum. The workshop identified a general set of Key Performance Indicators (KPIs) that can be further developed to measure learner engagement, skill acquisition, platform usability, and industry readiness. Additionally, the platform tools and requirements co-defined during the workshop ensure that XR training materials remain scalable, accessible, and technologically robust.

While the co-design process was highly collaborative, challenges emerged, particularly in ensuring accessibility, interdisciplinary alignment, and industry relevance. These were addressed through Universal Design for Learning (UDL) principles, iterative stakeholder feedback, and the integration of real-world XR applications. The use of interactive co-design tools such as Miro and Mentimeter enabled a dynamic and inclusive curriculum development process.

6.2 Next Steps

Following the successful co-design phase, the next step in the Alliance4XR project is the development of the first version of the teaching and training material under Task 2.2 and 2.3. This phase will focus on translating the co-designed curriculum into concrete, structured learning materials, ensuring alignment with pedagogical leading practices, technological feasibility, industry requirements, as well as providing opportunity to consider how to navigate implementation issues. Recommendations from the evaluation report point to the need for accessibility, standardisation, and industry-aligned applications in XR education, which will be core priorities in the iterative development process of Tasks 2.2 and 2.3

Key Priorities in Task 2.2:

1. Content Development: Expanding on the co-designed curriculum by creating teaching and learning resources that align with the learning outcomes and competencies defined in Task 2.1.
2. Integration of Digital and Green Skills: Ensuring that sustainability remains embedded within XR training scenarios, emphasising energy-efficient XR applications, eco-friendly design practices, and digital ethics.
3. Platform and Tool Optimisation: Refining the technological requirements to support immersive learning experiences across multiple devices, from VR headsets to desktop and mobile-friendly applications.
4. Educator and Student Preparation: Developing support materials, training strands, and onboarding guidelines to equip educators with the necessary skills to implement XR-enhanced teaching methodologies effectively.
5. Pilot Implementation Strategy: Establishing a clear testing and evaluation framework that will allow early adopters to provide structured feedback, refining the material before broader deployment.

The pilot phase will be essential in validating the curriculum's effectiveness, allowing adjustments based on real-world use cases. The KPIs defined for the pilot

implementation, including engagement rates, industry certifications, and platform usability, reflect stakeholder priorities and will guide the evaluation of the curriculum's real-world effectiveness, ensuring that learner engagement, technical proficiency, and ethical awareness are addressed.

6.3 Final Remarks

The Alliance4XR project has demonstrated that stakeholder collaboration is essential in designing effective, industry-relevant XR curricula. The success of this initiative depends on the continuous engagement of educators, industry experts, policymakers, and learners, ensuring that XR training remains innovative, practical, and widely accessible.

By maintaining a co-creative and iterative approach, the project will continue refining its teaching and training materials, ensuring they remain adaptable to technological advancements and evolving workforce needs. The structured alignment with European educational frameworks strengthens the curriculum's transferability and recognition, supporting lifelong learning and mobility across different education and employment sectors.

As the project moves forward with Task 2.2 and the pilot implementation phase, the commitment to quality, inclusivity, and innovation will ensure that Alliance4XR makes a lasting impact on XR education and vocational training. The collaborative spirit of this initiative will pave the way for the next generation of XR professionals, educators, and industry leaders, ensuring they are equipped with the skills necessary to thrive in an increasingly digital and sustainability-focused world.

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7 APPENDICES

Appendix A: List of Participating Organisations

The following organisations participated in the Alliance4XR International Focus Group Workshop and broader Task 2.1 curriculum co-design process:

Higher Education Institutions (HEIs)

- University College Dublin (UCD)
- Technological University of the Shannon (TUS)
- South East Technological University (SETU)
- Munster Technological University (MTU)
- University of Minho
- Trinity College Dublin (TCD)
- Politecnico di Milano
- Università Cattolica del Sacro Cuore

Vocational Training and Secondary Education Institutions

- APRO Formazione
- IS Federica
- Directorate of Secondary Education of Western Thessaloniki
- St Paul's Secondary School
- St. Olaf's National School
- Greystones Community College
- Laois Offaly Education and Training Board (LOETB)

Industry and Research Organisations

- Cyprus Marine and Maritime Institute (CMMI)
- SupportSquare
- Wodo Network
- Virtual Solutions
- AnotheReality

Government and Policy Representatives

- European Commission
- Ministry of Education Slovenia
- Ministry of Education Cyprus

Appendix B: Workshop Agenda.

Workshop Title: The Future of Education - XR Curriculum Co-Creation

Format: Hybrid (In-person at UCD & Online)

Date & Time: 16 January 2025, 10:00 AM – 2:00 PM (Dublin)

Location for in-person attendance: Newman Building, Room B108

Zoom registration link for online participation:

https://ucd-ie.zoom.us/meeting/register/UZZj4is1SjuDHMXZ4pEP2w

In-person Registration and Morning Refreshments: 9:30am – 10am

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Workshop Agenda

10:00 AM – 10:15 AM | Welcome and Introductions.

Description:

- Brief welcome by your host and key facilitators.
- Overview of workshop goals and schedule.

10:15 AM – 10:45 AM | Session 1: Presentation of WP1 Results

Description:

- Key insights from WP1, focusing on challenges, opportunities, and identified skills gaps for XR education.

10:45 AM – 12 PM | Session 2: Co-Design of Curriculum Structure

Description:

- Collaborative brainstorm in relation to the design and structure for XR-focused curricula, in alignment with European standards EQF, ECVET, and EQAVET.

12:00 PM – 12:30 PM | Lunch Break

12:30 PM – 1:00 PM | Session 3: Show and Tell of Existing Curriculum and Methods

Description:

- Showcasing curriculum materials, teaching methods, and innovative uses of XR in education.

1:00 PM – 1:45 PM | Session 4: Defining Platform Tools and KPIs

Description:

- Discussion regarding technical and functional requirements for XR platforms and identifying key performance indicators (KPIs) to evaluate pilot implementation.

1:45 PM – 2:00 PM | Closing and Next Steps

Description:

- Recap of the day's discussions and outputs.
- Outline of follow-up actions, deliverables, and deadlines.
- Closing remarks and acknowledgments.

Appendix C: Scoping Stimulus Materials

Proposed XR Training Curriculum for Students

1. Introduction to XR Technologies

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Introduce XR concepts and the types of XR: Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR).
- **Topics:**
    - Definition of XR, VR, AR, and MR.
    - History and evolution of XR technologies.
    - Overview of XR hardware (VR headsets, AR glasses) and software.
    - Applications of XR in different industries, with a focus on engineering.
    - The future of XR in education and industry.
- **Activities:**
    - Basic VR and AR demos.
    - Watch case studies showcasing XR in engineering contexts
- **Assessment:** Written quiz on XR basics and student presentations on potential uses of XR in engineering.

2. XR Hardware and Software Setup

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Familiarise students with XR hardware and software installation, configuration, and troubleshooting.
- **Topics:**
    - Overview of available XR platforms and devices (Microsoft HoloLens, etc.).
    - Requirements for XR software and hardware setup (compatibility, system specs).
    - Configuration of VR headsets and AR devices.
    - Introduction to Unity3D and Unreal Engine for XR development.
    - Key XR software tools:? (SketchUp, 3D Max)
- **Activities:**
    - Set up a VR system and install basic demo applications.
    - Connect AR devices to laptops and mobile devices.
    - Basic tutorial on creating a simple VR scene using Unity.
- **Assessment:** Practical test on setting up an XR system and configuring software.

3. XR Development for Engineering Applications

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Teach students to create XR content for specific engineering applications.
- **Topics:**
  - Overview of development platforms (e.g. Unity, Unreal Engine).
  - 3D modelling basics and importing models into XR environments.
  - Creating interactive VR/AR experiences.
  - Engineering simulations in XR (e.g. flow simulations, structural analysis, etc.).
  - Collaboration in virtual environments (e.g multi-user VR environments).
- **Activities:**
  - Create a simple AR application to overlay a 3D model of an engineering component in the real world.
- **Assessment:** Group project to develop an XR solution for an engineering problem.

4. Advanced XR Engineering Applications

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Explore advanced use cases of XR in various fields of engineering, with a focus on industrial and research applications.
- **Topics:**
  - XR in mechanical engineering, (simulations).
  - XR in civil engineering (virtual construction sites, real-time monitoring).
  - XR in electrical engineering (virtual circuit design and simulation).
  - XR for training and education in engineering (simulated labs, safety training).
  - User experience and human-computer interaction design in XR.
- **Activities:**
  - Create an immersive simulation for a large-scale civil engineering project.
- **Assessment:** Students create and present a working prototype demonstrating an advanced XR engineering application.

Proposed XR Training Curriculum for Educators in Higher Education

1. Introduction to XR in Education

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Provide an overview of XR technologies and their potential for enhancing education in higher education settings.
- **Topics:**
  - What is XR: Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR)?
  - History and evolution of XR in education.
  - Current and emerging trends in XR for higher education.
  - Pedagogical theories supporting XR use in teaching (constructivism, experiential learning, etc.).
  - Case studies: Successful applications of XR in different disciplines (medicine, humanities, engineering).
- **Activities:**
  - Analyse case studies where XR was successfully implemented in a teaching context.
- **Assessment:** QRs for the participants to assess the potential benefits and challenges of using XR in their specific discipline.

2. Understanding XR Hardware and Software

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Familiarise educators with the necessary hardware and software for XR.
- **Topics:**
  - Overview of XR hardware: VR headsets (e.g., Oculus Quest), AR devices (e.g., Microsoft HoloLens).
  - XR software platforms for education (e.g. EON XR, Engage VR, Siemens NX VR, Autodesk VR, SolidWorks XR)
  - Setting up XR hardware in a classroom or lab.
  - Cross-platform compatibility and device management in an educational setting.
  - Tools for creating immersive content (e.g. Unity, Unreal Engine, WebXR tools).
- **Activities:**
  - Hands-on setup of VR and AR hardware in a simulated classroom.
  - Guided tutorials for installing and testing basic educational XR apps.
  - Explore virtual classrooms and AR experiences designed for higher education.
- **Assessment:** Practical test on setting up an XR system for classroom use.

3. Pedagogical Integration of XR into Teaching

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Equip educators with strategies to integrate XR into their existing curriculum and enhance learning experiences.
- **Topics:**
  - Instructional design frameworks for XR-enhanced learning.
  - Matching XR experiences with learning objectives (e.g., using VR for simulations, AR for interactive overlays).
  - Student-centred learning through immersive experiences.
  - Designing XR experiences for accessibility (for students with physical disabilities, visual or hearing impairments).
  - Engaging students with mixed-reality activities (role-playing, simulations, labs).
  - Evaluating student learning in XR environments.
  - Ethical use of immersive technologies in the classroom.
  - Student engagement metrics in virtual and augmented experiences.
  - Collecting student feedback on XR-enhanced learning.
- **Activities:**
  - Plan a lesson incorporating AR/VR based on learning outcomes.
  - Group collaboration in VR spaces to simulate student experiences.
  - Case studies of XR in different disciplines (STEM, humanities, arts).
- **Assessment:** Design a detailed lesson plan integrating XR with clearly defined learning objectives. Create an evaluation plan for an XR-based lesson, including feedback mechanisms and learning assessments.

4. XR Content Creation for Teaching

- **Duration:** Approximately 2–3 hours (flexible based on context)
- **Objective:** Train educators on how to create and adapt XR content for their courses.
- **Topics:**
  - Introduction to XR content creation tools (Unity etc)
  - Basic 3D modelling and importing content into XR environments.
  - Creating interactive AR experiences (e.g., AR overlays for buildings, historical artifacts).
  - Designing VR scenarios for immersive learning (virtual labs, historical reconstructions, role-playing simulations).
  - Incorporating multimedia elements (audio, video, images) into immersive experiences.
- **Activities:**
  - Build a basic AR experience using an open source platform such as Unity, relevant to a course topic.
  - Create a simple VR environment where students can interact with 3D models.
  - Modify existing XR content to align with teaching goals.
- **Assessment:** Educators submit a prototype XR activity or experience that aligns with their curriculum.

5. FINAL RESULT: XR-Enhanced Teaching Module and Integration with Future Deliverables

Building on the curriculum framework developed in WP2.1, this section outlines the next steps in the project plan, focusing on refining, implementing, and scaling the XR-enhanced teaching module. Informed by the co-design process and ongoing feedback from consortium partners, knowledge exchange events, and project evaluators, these steps ensure the module aligns with project objectives and industry **needs.**

5.1 Development and Implementation of the XR-Enhanced Teaching Module

- **Design and Implementation:** Building on the curriculum developed in WP2.1, a fully integrated XR-enhanced teaching module will be designed and implemented by the consortium. This module will incorporate insights from the co-design phase and ensure alignment with industry and market needs as mapped in WP1.
- **Immersive learning activities**: Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) learning activities will be structured to support course objectives, ensuring accessibility and engagement for learners.
- **Pilot testing and evaluation (WP4 & WP5)**: The module will undergo pilot implementation with select student and teacher groups, following the first demonstration activities of the ALLIANCE4XR curricula.
- **Feedback analysis and refinement (Deliverable 2.3, WP2 & WP5)**: Data from pilot testing will be systematically collected and analysed to inform iterative refinements, contributing to the second version of the XR training materials.

5.2 Alignment with Related Work Packages and Deliverables

- **WP2 (Teaching and Training Material Development)**
  - The XR module will serve as a core component of Deliverable 2.2 (First Version of ALLIANCE4XR Curricula), ensuring consistency with the pedagogical approach outlined in WP2.
  - Iterative improvements will be captured in Deliverable 2.3 (Second Version of Teaching and Training Material, Month 24).
- **WP3 (Platform Development and Digital Tools)**
  - The XR module will be integrated into the ALLIANCE4XR platform (Deliverable 3.2), ensuring seamless digital deployment.
  - Specification requirements from WP3 will inform compatibility with various XR hardware/software configurations.
- **WP4 (Demonstration and Multiplier Activities)**
  - The module will be implemented in the first round of demonstration activities (Milestone MS5, Month 17), enabling an initial assessment of its impact.
  - A second round of demonstrations (MS6, Month 36) will integrate refinements and additional stakeholder feedback.
- **WP5 (Monitoring, Assessment, and Validation)**
  - Assessment of the module's effectiveness will be embedded within Deliverable 5.1 (Monitoring and Assessment Plan, Month 13).

    - The final version will contribute to Deliverable 5.2 (Validated Methodology and Recommendations, Month 35), ensuring long-term impact.
- **WP6 (Dissemination and Stakeholder Engagement)**
    - The module will be actively promoted within the ALLIANCE4XR network and through ambassador engagement.
    - Resources and findings will be shared through multiplier events and open-access dissemination platforms.

5.3 Defining Consortium Roles and Next Steps

- Each consortium partner will contribute expertise in refining and validating the module, ensuring an inter-disciplinary approach.
- UCD will coordinate integration with pedagogical strategies, while WP3 partners will oversee technological alignment.
- Continuous engagement with industry and educational stakeholders will ensure the module remains aligned with evolving digital and green skills needs.

5.4 Conclusion

8 5.4 Conclusion

The completion of the curriculum development marks a key milestone in the ALLIANCE4XR project, providing a solid foundation for the next phase: the further development and implementation of the XR-enhanced teaching module. The following sections outline the steps needed to refine, pilot, and scale this module, ensuring it effectively integrates immersive technologies with pedagogical best practices. Through an iterative process informed by co-design, pilot testing, and stakeholder engagement, the module will continue to evolve to meet the dynamic needs of both learners and industry. Alignment with related work packages ensures a cohesive and scalable approach, reinforcing the project's impact across education and workforce training. As the consortium progresses, collaboration and continuous refinement will be essential in ensuring that the XR-enhanced teaching module remains innovative, accessible, and adaptable to future advancements in digital and green skills education.