# Alliance4XR

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

## D2.2 Development of the 1st version of the teaching and training material

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| **Abstract (for dissemination)** | This report outlines the development of the Alliance4XR curriculum framework as part of Task 2.2, building on the foundational architecture defined in D2.1. The curriculum is designed to address the emerging demand for Extended Reality (XR) skills across sectors, supporting both student and educator pathways from EQF levels 4 to 7. It is structured around six modular strands that reflect technical, pedagogical, and ethical competencies in immersive learning. The methodology draws on European quality assurance frameworks gathering EQAVET and ECVET, Universal Design for Learning (UDL), and constructivist pedagogy, ensuring accessibility, portability, and contextual relevance. Feedback from WP4 piloting activities has informed iterative refinements in learning outcomes, assessment, and educator support. The curriculum is designed for flexible implementation across VET, HEI, and CPD contexts, with micro-credentials, capstone integration, and XR platform compatibility built in. This report also outlines recommendations for piloting, scaling, and ensuring long-term sustainability across the Alliance4XR partnership. |

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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 |
| **EU** | European Union |
| **QB** | Quality Board |

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|---|---|
| **CCD** | Collaborative Curriculum Design |
| **UDL** | Universal Design for Learning |
| **EQF** | European Qualification Framework |
| **ECVET** | European Credit system for Vocational Education and Training |
| **EQAVET** | European Quality Assurance Vocational Education and Training |
| **EDCI** | European Digital Credentials Infrastructure |
| **LO** | Learning Outcome |
| **CPD** | Continuing Professional Development |
| **DC** | Digital Credential |
| **RPL** | Recognition of Prior Learning |
| **WP** | Work Package |
| **TLA** | Teaching, Learning and Assessment |
| **PBL** | Project Based Learning |

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## GLOSSARY OF TERMS

| Term | Definition |
|---|---|
| **Accessibility Features (in XR)** | Tools and design elements—such as captions, voice control, screen-reader compatibility, or alternative input methods—that support learners with diverse abilities in XR environments. |
| **Alliance4XR** | A European project aiming to develop XR skills through modular, competency-based curricula for vocational and higher education. |
| **AR (Augmented Reality)** | Technology that overlays digital content (images, sounds, data) onto the real world, typically viewed through smartphones or AR glasses. |
| **Assessment Rubric** | A structured scoring guide used to evaluate learner performance against defined criteria and levels of achievement. |
| **Bias Mitigation in XR** | The process of identifying and reducing stereotypes, exclusion, or unfair representation in XR content, ensuring equitable learning experiences. |
| **Blended Learning** | A combination of face-to-face instruction with digital or online learning activities. |
| **Capstone Project** | A final, summative project where learners demonstrate integrated knowledge, skills, and ethical awareness by addressing a real-world challenge. |
| **Competency-Based Learning** | An educational approach in which learners progress by demonstrating mastery of specific skills, knowledge, or attitudes. |
| **Constructivism** | A learning theory which holds that learners actively construct knowledge through experience, reflection, and interaction. |
| **Cross-Strand Integration** | A curriculum design approach where learning outcomes and concepts from different strands reinforce one another, supporting interdisciplinary learning. |
| **Curriculum Framework** | A structured plan outlining content, learning outcomes, pedagogy, and assessment strategies for educational programmes. |
| **Desktop 3D Environment** | Interactive 3D simulations accessed via standard computers or tablets without spatial immersion |

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| **Digital Credential (EDCI-compatible)** | A verifiable, portable, digital record of a learner's achievement, often aligned with Europass and EQF. |
| **ECVET (European Credit system for Vocational Education and Training)** | A framework for recognising, transferring, and accumulating learning outcomes and credits across EU VET systems. |
| **EDCI (European Digital Credentials Infrastructure)** | A digital infrastructure supporting standardised, secure, and portable recognition of learning achievements in Europe. |
| **EQAVET (European Quality Assurance for Vocational Education and Training)** | A framework supporting systematic quality assurance and improvement in vocational training. |
| **EQF (European Qualification Framework.)** | A common reference framework for comparing education qualifications across Europe, structured by eight levels. This project focuses on EQF Levels 4 to 7, covering qualifications from upper secondary (high school) to master's level. |
| **Ethics in XR** | The consideration of fairness, privacy, inclusion, safety, and sustainability when designing or using immersive technologies. |
| **Experiential Learning** | A pedagogical model where learners acquire knowledge and skills through active participation, reflection, and real-world application. |
| **Formative Assessment** | Ongoing evaluation aimed at guiding learning and informing instruction before final assessments. |
| **GenAI** | AI systems capable of creating new content (text, images, environments), increasingly integrated into XR for responsive, adaptive learning. |
| **Green Skills** | Skills and knowledge that support environmentally sustainable practices, especially in energy-intensive or technology-driven fields like XR. |
| **Inclusive Design** | The practice of creating XR tools and content that are accessible and usable by as many people as possible, regardless of ability or background. |
| **Intelligent XR (IXR)** | XR systems enhanced by artificial intelligence, capable of adaptive interaction, personalised feedback, or intelligent environments. |
| **Learning Outcomes (LOs)** | Statements specifying what a learner is expected to know, understand, and be able to do after a learning experience. |

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| **Learner-Centred Design** | An instructional approach that prioritises the needs, preferences, and agency of learners in the design of educational experiences. |
| **Micro-Credential** | A short, focused certification that recognises mastery of a specific set of skills or knowledge, often stackable toward larger qualifications. |
| **Mixed Reality (MR)** | The blending of real and digital environments in real time, enabling the user to interact with both virtual and physical objects, while virtual objects can dynamically respond to physical ones within the shared space. According to Milgram et al.'s Reality–Virtuality continuum [13], MR spans the middle ground between the real and virtual worlds, incorporating both Augmented Reality (AR)—where virtual content overlays the real environment—and Augmented Virtuality (AV)—where real-world elements are integrated into predominantly virtual content. |
| **Modular Curriculum** | A curriculum made of self-contained, stackable units (called strands in Alliance4XR) that can be combined flexibly to suit diverse learning needs. |
| **Pedagogical Framework** | The set of educational theories, strategies, and values that guide how teaching and learning are structured. |
| **Portfolio Assessment** | A method of evaluation using a curated collection of student work to demonstrate learning and progression over time. |
| **Recognition of Prior Learning (RPL)** | The formal acknowledgment of learning acquired outside of traditional education. |
| **Reflective Practice** | The ongoing process of critically reviewing one's teaching or learning to enhance future performance and decision-making. |
| **Remote XR** | XR learning that is accessed from a distance using cloud-based tools or remote servers, enabling location-independent XR experiences. |
| **Scenario-Based Learning** | An instructional method using realistic situations and role-playing to help learners apply knowledge in practical contexts. |
| **Spiral Learning** | A strategy where core ideas are revisited at increasing levels of complexity, deepening understanding over time. |
| **Strand** | A thematic unit in the Alliance4XR curriculum containing a cluster of related learning outcomes focused on a specific XR domain. |

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| **Summative Assessment** | A final evaluation that measures whether learners have achieved intended outcomes. |
| **Technology-Enhanced Learning (TEL)** | The use of digital technologies, including XR, to enrich educational delivery, engagement, and effectiveness. |
| **Universal Design for Learning (UDL)** | An educational framework promoting inclusive learning by providing multiple ways for learners to access content, express understanding, and stay engaged. |
| **Virtual Reality (VR)** | A fully immersive digital environment delivered via various visual systems, including user-centric devices like head-mounted displays (HMDs) and room-centric setups such as CAVE systems or projection rooms. VR relies on tracking and multi-sensorimotor technologies to provide complete sensory simulation and enable natural, immersive interaction within a purely virtual 3D space. In this project, we focus on headset-based technologies, typically integrating an HMD, motion tracking (inside-out or outside-in), and handheld controllers for interaction. |
| **XR (Extended Reality)** | A term encompassing Virtual Reality (VR) and Mixed Reality (MR), the latter especially including Augmented Reality (AR) as previously highlighted in the MR definition above. XR refers to a spectrum of technologies that blend real and virtual environments to enable immersive, interactive experiences, allowing users to engage naturally with both digital and physical elements. |
| **XR Delivery Models** | Different approaches to delivering XR-based education, including immersive, desktop, blended, and remote formats. |
| **XR Learning Platform** | A software environment and learning management system that supports XR content creation, immersive and 3D interactive experiences, as well as delivery, tracking, and assessment. |

# 1. EXECUTIVE SUMMARY

This report outlines the development and specifies the content of the first version of the **Alliance4XR curriculum and training framework**. Building on the needs and gap analysis described in WP1 and the curriculum structure introduced in **Deliverable 2.1**, this document refines and extends the initial strand-based design by incorporating stakeholder feedback, integrating European education standards, and aligning with sectoral priorities in XR.

The curriculum framework is composed of **six strands**, applicable to both **students** and **educators**, with structured learning outcomes mapped to **EQF Levels 4–7**, covering qualifications from upper secondary (high school) to master's level. These strands are designed to be **modular, cross-sectoral, and stackable**, supporting use in **VET, HEI, and CPD** contexts. The framework provides pathways for full programme delivery, micro-credentialing, and hybrid course formats.

Key pedagogical foundations include **constructivism, spiral learning**, and **Universal Design for Learning (UDL)**, ensuring that curriculum content is inclusive, scalable, and responsive to diverse learner needs. Each strand includes **competency-based learning outcomes**, integrated with assessment criteria that align with **EQF**, **ECVET**, and **EQAVET** standards. This enables **transparent recognition of learning**, **credit portability**, and **learner mobility** across national and European systems.

The document incorporates findings from the **D4.2.1 stakeholder feedback report**, which emphasised the need for improved guidance for educators, clearer EQF differentiation, and more usable course design resources. In response, this deliverable includes **updated assessment rubrics**, **course planning templates**, and examples of curriculum application in **VET and HEI settings**. A dedicated section also outlines **capstone project integration**, resource banks, and digital delivery via the **Alliance4XR platform**.

Looking ahead, the report outlines steps for **pilot implementation**, **resource refinement**, and **scaling across sectors and EQF levels**. It emphasises the importance of ongoing collaboration, stakeholder engagement, and quality assurance to ensure that the curriculum remains relevant, inclusive, and

responsive to technological and pedagogical developments. Overall, Deliverable 2.2 presents a robust and adaptable curriculum foundation, ready for iterative testing, evaluation, and enhancement in the next phase of the Alliance4XR project.

# 2. 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) and Mixed Reality (MR)—the latter especially including Augmented Reality (AR) as described by Milgram et al.'s (1994) Reality–Virtuality continuum [13], 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 curriculum framework 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.

## 2.1 Structure of the Report

The **D2.2 report** outlines the development and content of the first version of the *Alliance4XR curriculum framework* and associated teaching resources. It is structured to reflect the iterative and evidence-informed approach adopted for curriculum design, grounded in European frameworks such as EQF, EQAVET [7], and ECVET [5].

The report begins with an **Introduction** section that clarifies the objectives of Task 2.2, situates it within the broader project lifecycle, and explains its relationship to prior deliverables, particularly D2.1. It then details the **methodology and theoretical foundations**, including pedagogical models (such as spiral learning, constructivism, and experiential learning), and how Universal Design for Learning (UDL) [3], and accessibility principles are embedded in curriculum alignment.

Section 3 presents the **curriculum framework structure**, articulating both the student and educator learning outcomes across six thematic strands. Each strand is aligned with EQF levels and supported by modular design principles, with examples of course combinations across VET and HEI settings. Strand-based learning outcomes are mapped to EQF domains and structured to support micro-credentialing and flexible delivery.

Section 4 addresses **implementation and course design**, offering guidance on building learner-focused programmes, integrating XR delivery models, and deploying platform tools. It also covers the use of assessment tools, micro-credentials, and recognition pathways.

Section 5 focuses on **monitoring, evaluation, and quality assurance**, incorporating stakeholder feedback and linking curriculum development to EQAVET indicators.

Finally, **Section 6** offers concrete **recommendations and future directions**, outlining steps for refinement, piloting, scaling, and long-term sustainability. The report also includes appendices with rubrics, tools, and templates to support adoption.

## 2.2 Overview and Objectives of Task 2.2

Task 2.2 focuses on the development of the first version of the Alliance4XR teaching and training curriculum, aligned with the project's strategic vision of enabling inclusive, interdisciplinary, and future-oriented XR education across vocational and higher education systems. Building on the foundational research and conceptual structure established in Task 2.1, this task operationalises the curriculum by defining learning outcomes, pedagogical frameworks, delivery formats, and quality assurance mechanisms, specifically tailored to EQF levels 4–7, covering qualifications from upper secondary (high school) to master's level.

The key objective of Task 2.2 is to produce a modular, strand-based curriculum framework that supports flexible implementation by VET providers, HE institutions, and CPD actors. It addresses the need for cross-sectoral XR competences by integrating strands such as XR fundamentals, technical deployment, engineering applications, sector-specific use cases, collaborative virtual environments, and capstone innovation projects.

The framework incorporates principles from EQAVET [8], ECVET [5], and UDL [3] , ensuring that the curriculum is not only technically robust but also accessible, adaptable, and pedagogically sound. Learning outcomes are written at multiple EQF levels, enabling progression and stackability through a spiral learning model. Feedback from WP4 pilot workshops (Task 4.2) and multi-stakeholder engagement has informed the curriculum structure, supporting the responsiveness of the framework to labour market and learner needs.

The output of Task 2.2 includes a structured set of learning outcomes per strand, mapped to EQF levels and ECVET credits, accompanied by sample assessment

rubrics and implementation guidance. These deliverables set the stage for piloting, refinement, and future micro-credential development under subsequent project tasks and work packages.

## 2.3 Methodology and Evidence Base (including D4.2 Feedback)

The development of the Alliance4XR curriculum in Task 2.2 builds on the structural foundation established in Task 2.1 and follows a stakeholder-informed, iterative methodology aligned with the European Quality Assurance Framework for Vocational Education and Training (EQAVET). In keeping with EQAVET's four-phase model—Planning, Implementation, Evaluation, and Review—the approach aims to ensure transparency, responsiveness, and adaptability across diverse educational contexts.

**Planning Phase**

The curriculum structure and EQF-aligned learning outcomes were first defined in D2.1 having been informed through the work undertaken in WP1 and the co-design activities involving academic, vocational, and industry partners. These learning outcomes were developed to reflect the project's overarching goals: fostering XR competencies across sectors, ensuring cross-level alignment (EQF 4–7), and supporting both formal education and lifelong learning. The development was further informed by analysis of XR skills needs, as outlined in the project proposal.

**Implementation Phase**

Task 2.2 focused on translating the initial curriculum into a more delivery-ready format. This involved articulating assessment criteria, mapping progression across EQF levels, and embedding core pedagogical frameworks such as spiral learning, constructivism, experiential learning, and Universal Design for Learning (UDL). However, while these principles informed the structure, significant redesign or modular restructuring of strand content was not undertaken at this stage. Instead, emphasis was placed on setting the groundwork for a modular XR learning application designed to support educator-led adaptation.

**Evaluation Phase – Incorporating D4.2.1 Feedback**

Feedback from pilot stakeholders, documented in the D4.2.1 report identified practical challenges and developmental needs. Key findings included:

- The need for clearer guidance on integrating XR tools into teaching practice

- Uncertainty around how to differentiate content and expectations across learner levels (EQF 4–7)
- A call for more robust educator support materials, including examples and adaptable delivery strategies.

While D4.2.1 did not critique the curriculum's core structure or learning outcomes in detail, it highlighted usability and implementation barriers. These insights informed subsequent development work, including refinement of assessment rubrics, educator-facing resources, and clearer EQF scaffolding.

**Review Phase**

An ongoing review process is planned to ensure responsiveness to future pilot data and evolving sector needs. This includes the integration of EQF scaffolding, ECVET-compatible credit mapping, and formalised stakeholder feedback loops. These efforts support alignment with EQAVET's emphasis on continuous improvement, transparency, and relevance.

In summary, while Task 2.1 provided a strong structural foundation, Task 2.2 has clarified priorities for practical delivery and pedagogical alignment. Stakeholder feedback, especially from D4.2, has underscored the need for targeted supports and implementation models, which now guide the next stage of curriculum enhancement.

## 2.4 Theoretical Underpinnings for Teaching and Training Design

The teaching and training design of the Alliance4XR curriculum is anchored in contemporary educational theory that supports inclusive, progressive, and practice-driven learning. These theoretical foundations guide how learning should happen, regardless of format or delivery mode, and inform the pedagogical strategies adopted by educators and trainers working across the Alliance4XR ecosystem [1].

Three interrelated learning theories underpin this model:

**Spiral Learning [2]**

- **How it informs the model:** Spiral learning supports a curriculum structure that revisits core XR concepts and competencies (e.g., ethics, user experience, spatial design) at progressively and notes deeper levels. This is

evident in how the learning outcomes are scaffolded across EQF levels—what begins as basic understanding at Level 4 evolves into innovation and leadership at Level 7.

- **Curriculum implication:** It justifies modular strand design, allowing learners to re-enter or progress along flexible pathways, while reinforcing earlier knowledge in new applications (e.g., XR hardware in Strand 2, revisited in Strand 5 for collaborative integration).

**Experiential Learning [12]**

- **How it informs the model:** The curriculum is intentionally designed around hands-on XR activities, including simulations, real-world projects, and interactive assessment formats (e.g., capstone work, scenario-based demos).
- **Curriculum implication:** Encourages project-based learning and embedded assessment strategies that mirror workplace practice. For example, Strand 6 requires students to apply learned skills in designing and presenting an XR solution to a real-world problem—fully aligned with Kolb's cycle of experience, reflection, conceptualisation, and experimentation.

**Constructivism [15][16][17]**

- **How it informs the model:** Knowledge is constructed through learner-led inquiry, especially in complex or ethically charged areas (e.g., data privacy, AI integration, inclusive XR environments).
- **Curriculum implication:** Encourages collaborative problem-solving, dialogue, and ethical reasoning. Learning activities in Strand 3 (e.g., instructional design) and Strand 5 (e.g., reflection on immersive teaching) exemplify this.

These pedagogical models are framed through **Universal Design for Learning (UDL)** principles [3], ensuring the curriculum remains accessible, inclusive, and responsive to diverse learner needs. The resulting design encourages flexibility, progression, and real-world applicability. This pedagogical foundation ensures that the curriculum is not just technically relevant, but also learner-centred,

inclusive, and aligned with the educational ambitions of both vocational and higher education institutions.

## 2.5 Relationship with Alliance4XR Work Packages

The development of the Alliance4XR curriculum in Task 2.2 is part of a wider, integrated strategy across multiple work packages in the project. This section clarifies how D2.2 aligns with and builds upon work carried out in other areas of the project, particularly those related to curriculum design, stakeholder engagement, piloting, and platform development.

D1.1 and D1.2 (Work Package 1) laid the foundations by mapping existing XR education and training initiatives across Europe, analysing stakeholder needs, and identifying gaps in XR skills. This evidence base directly informed the curriculum strands defined in D2.1, which established the modular structure, EQF-aligned learning outcomes, and strand architecture forming the backbone of the Alliance4XR curriculum. Task 2.2 builds on that foundation by refining these elements and supporting delivery readiness.

Feedback from early piloting activities in D4.2.1 (Work Package 4) has been integrated into D2.2 through improvements in EQF differentiation, educator support, assessment design, and user guidance. This ensures the curriculum is not only theoretically robust but also practically usable across diverse learning environments.

Moreover, the curriculum content and structure are being designed to integrate smoothly with the Alliance4XR platform (WP5), ensuring that digital delivery, content sharing, and learner tracking are enabled. Future reporting in WP6 (Policy and Sustainability) will draw upon D2.2 to ensure alignment with European policy frameworks (e.g., EQAVET [8], ECVET [5], EDCI [6], European Commission, 2008,& 2009 [9][10]) and enhance cross-border transferability. In this way, Task 2.2 acts as a pivotal connector across the Alliance4XR work packages, linking design, delivery, piloting, and policy in a coherent, iterative cycle of curriculum development.

# 3. CURRICULUM FRAMEWORK STRUCTURE

This section outlines the design architecture of the Alliance4XR curriculum framework and explains how pedagogical principles have been translated into a practical, modular framework. Building directly on the theoretical models introduced in Section 2.3, the curriculum structure supports flexible implementation across VET, HEI, and CPD contexts while maintaining coherence with European education and training standards.

At the core of the design are six cross-sectoral strands, namely:

1. Introduction to XR Technologies,
2. XR Hardware and Software Setup,
3. XR for Engineering and Applied Sciences,
4. Applications Across Industries,
5. Collaborative and Social XR Environments,
6. Capstone Project - Ethical and Practical XR Solutions,

each comprising four learning outcomes that represent progressive levels of competence. These outcomes are written to align with the European Qualifications Framework (EQF), allowing for clear scaffolding from foundational to advanced levels (EQF 4 to 7). The modular strand format enables educators and institutions to deliver content as standalone units, integrate them into broader programmes, or build bespoke micro-credentials.

The curriculum framework is informed by pedagogical principles such as spiral learning, experiential learning, and constructivism, which are embedded not only in content but also in sequencing, assessment design, and learner progression. Universal Design for Learning (UDL) principles further ensure that the framework accommodates diverse learner needs and teaching settings, particularly in relation to XR delivery environments.

Subsequent subsections detail the application of these design principles, the structure of each strand, the approach to assessment and crediting, and guidance for aligning course development with EQF, EQAVET, and ECVET standards. Together, these elements create a curriculum that is both pedagogically sound and practically implementable across a range of education and training scenarios.

## 3.1 Curriculum Design Principles (Spiral Learning, EQF, Constructivism)

While Section 2.3 outlines the pedagogical rationale for teaching and training, this section explains how those theoretical models have shaped the structure of the Alliance4XR curriculum framework.

The curriculum is built on three core design principles:

- **EQF-Aligned Progression:** Each strand includes learning outcomes written at multiple levels (EQF 4 to 7), allowing for progression from introductory to advanced applications. This scaffolding enables flexible pathways and supports both entry-level learners and advanced practitioners.
- **Strand-Based Modularity:** The curriculum is organised into six thematic strands. Each strand contains four core learning outcomes, designed to function as discrete learning units or be combined across strands to create tailored learning pathways, including micro-credentials.
- **Spiral and Constructivist Structuring:** The modular design supports a spiral approach by allowing learners to revisit and deepen core XR competencies (e.g., ethics, technical deployment, collaboration) across strands and levels. Constructivist pedagogy is embedded through scenario-based tasks, capstone projects, and learner-led exploration.

Together, these design principles allow for flexible delivery by VET and HE providers, clear EQF-level differentiation, and the integration of cross-sector XR skills. They translate pedagogical theory into a practical, scalable curriculum structure that supports real-world learning, credential transparency, and European mobility.

## 3.2 Strand-Based Learning Outcomes and Modular Structure

The Alliance4XR curriculum is organised around six coherent and interrelated strands, each representing a foundational area in the development, application, and ethical implementation of extended reality (XR) technologies. These strands provide the structural backbone of the curriculum and are designed to be modular,

stackable, and adaptable across formal, informal, and sector-specific learning contexts [4][14].

Each strand contains four learning outcomes, aligned to the European Qualifications Framework (EQF). These outcomes progress in depth and complexity across EQF Levels 4 to 7, allowing learners to build their knowledge and skills through spiral learning. Concepts such as ethical reasoning, collaboration, and usability reappear across levels, increasing in complexity and responsibility as learners advance.

**Student Alliance 4XR Curriculum Strands, EQF Level, Thematic Focus, and Associated Learning Outcomes:**

| Strand Title | EQF Level | Thematic Focus | Associated Learning Outcomes |
|---|---|---|---|
| **Strand 1: Introduction to XR Technologies** | EQF 4–6 | Foundations of XR technologies and their societal implications | **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.<br>**1.2** Describe the historical development and future trends in XR technology.<br>**1.3** Identify key hardware and software components used in XR environments.<br>**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** | EQF 4–6 | Technical setup and software operation for XR systems | **2.1** Demonstrate the ability to set up, configure, and troubleshoot XR hardware (headsets, AR devices, motion tracking systems, etc.).<br>**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.<br>**2.4** Assess the privacy risks associated with data collection in XR devices and propose leading practices for responsible use. |
| **Strand 3: XR for Engineering and Applied Sciences** | EQF 5–7 | Development of XR simulations for scientific and engineering contexts | **3.1** Utilise 3D modelling tools to create assets for XR applications.<br>**3.2** Develop interactive XR simulations for engineering and applied science applications.<br>**3.3** Implement real-time physics and spatial interactions within XR environments.<br>**3.4** Analyse ethical considerations in XR engineering applications, including safety, accessibility, inclusivity in virtual spaces and the impact of GenAI. |
| **Strand 4: XR Applications Across Industries** | EQF 5–7 | Use of XR in applied professional and industrial scenarios | **4.1** Apply XR solutions to specific industry needs (including structural engineering, energy and grids, and the maritime sector).<br>**4.2** Design scenario-based training simulations that mirror real-world job environments.<br>**4.3** Optimise user interaction and experience design for different audiences.<br>**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 Social XR Environments** | EQF 5–7 | Social interaction, collaboration and safety in 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.<br>**5.3** Develop social XR applications that encourage effective communication and engagement.<br>**5.4** Address cybersecurity and user safety concerns in networked XR environments. |
| **Strand 6: Capstone Project - Ethical and Practical XR Solutions** | EQF 6–7 | Practical application and ethical reflection in XR projects | **6.1** Design and develop a fully functional XR application addressing a real-world problem.<br>**6.2** Integrate ethical frameworks into the project development process, ensuring responsible innovation including green skills.<br>**6.3** Conduct user testing and feedback analysis to improve XR usability and accessibility.<br>**6.4** Present findings in a professional demonstration and written report, detailing technical execution and ethical considerations. |

**Educator Alliance 4XR Curriculum Strands, Thematic Focus, and Associated Learning Outcomes**

| Strand Title | EQF Level | Thematic Focus | Associated Learning Outcomes |
|---|---|---|---|
| **Strand 1: Introduction to XR in Education** | EQF 5–6 | Pedagogical Foundations and Ethical Awareness in XR Integration | 1.1 Explore the pedagogical potential of XR technologies in education.<br>1.2 Compare different learning theories related to immersive learning.<br>1.3 Identify challenges in XR adoption for teaching and propose solutions.<br>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** | EQF 5–6 | Technical Proficiency and Ethical Deployment of XR Tools | 2.1 Demonstrate setup and troubleshooting of XR classroom tools.<br>2.2 Evaluate platform compatibility and accessibility features.<br>2.3 Select appropriate XR applications for different educational settings.<br>2.4 Ensure ethical handling of student data and informed consent in XR learning environments. |
| **Strand 3: Pedagogical Strategies for XR Integration** | EQF 5–7 | Instructional Design and Inclusive Teaching Practices in XR | 3.1 Develop teaching and learning plans incorporating XR to enhance subject learning.<br>3.2 Apply active learning principles to XR-based instruction.<br>3.3 Assess learning outcomes in XR-enhanced lessons.<br>3.4 Foster inclusive and accessible learning environments in immersive education settings. |
| **Strand 4: XR Content Creation for Educators** | EQF 6–7 | Content Development and Assessment for Immersive Learning | 4.1 Use XR authoring tools to create interactive learning materials.<br>4.2 Adapt existing 3D content for use in educational settings.<br>4.3 Implement assessment techniques for measuring student engagement in and learning through XR.<br>4.4 Address bias and ethical concerns in XR educational content development. |
| **Strand 5: Evaluating and Improving XR-Enhanced Teaching** | EQF 6–7 | Reflective Practice, Evaluation, and Continuous Improvement | 5.1 Critically assess student engagement and learning effectiveness in XR lessons.<br>5.2 Collect and analyse student feedback to improve XR teaching<br>Dear Ekaterina,<br><br>Do you have any updates regarding a potential special session for XR4HUMAN at EuroXR 2025?<br><br>Dear Ekaterina, |

| | | | |
|---|---|---|---|
| | | | Do you have any updates regarding a potential special session for XR4HUMAN at EuroXR 2025?<br><br>methodologies.<br>5.3 Reflect on ethical responsibilities in immersive teaching, including green skills, content moderation and age-appropriate design.<br>5.4 Design an XR-enhanced teaching strand and present it to peers for evaluation. |

This modular structure supports:

- Flexible program/course assembly
- Stackable learning
- Progressive differentiation

### 3.2.1 Examples of Modular Application

The modularity of the Alliance4XR curriculum allows institutions to configure bespoke programmes tailored to their learners' needs, institutional context, and sectoral focus. Below are illustrative examples of such a modular application, based on verified EQF-level alignments:

**Student Curriculum**

**Example A: Level 5 VET Programme (XR for Industry Contexts)**

- **Strand 1 – Introduction to XR Technologies**

  (Foundation in XR definitions, history, components, and ethics)

- **Strand 2 – XR Hardware and Software Setup**

  (Technical and practical configuration skills)

- **Strand 4 – XR Applications Across Industries**

  (Scenario design and sector-specific simulation development)

**Example B: Level 7 HE Capstone Course (Advanced XR Development)**

- **Strand 3 – XR for Engineering and Applied Sciences**

  (3D modelling, physics, simulation development)

- **Strand 5 – Collaborative and Multi-User XR Environments**

  (Networking, social XR design, multi-user interaction)

- **Strand 6 – Capstone Project**

  (Design and presentation of an XR solution with ethical reflection)

**Educator Curriculum**

**Example A: Level 5–6 VET Educator Training (Practical XR Integration)**

- **Strand 1 – Introduction to XR in Education**

  (Pedagogical foundations and ethical awareness)

- **Strand 2 – XR Hardware and Software for Teaching**

  (Tool setup, platform evaluation, classroom application)

- **Strand 3 – Pedagogical Strategies for XR Integration**

  (Lesson planning, active learning, inclusivity)

**Example B: Level 7 HEI Educator CPD Course (Instructional Innovation)**

- **Strand 4 – XR Content Creation for Educators**

  (XR authoring, assessment design, bias mitigation)

- **Strand 5 – Evaluating and Improving XR-Enhanced Teaching**

  (Reflective practice, ethics, learner feedback analysis)

- **Strand 6 – XR Innovation Capstone**

  (Design and peer presentation of an XR-enhanced teaching strand)

### 3.2.2 Cross-Strand Integration and Sectoral Relevance

Although each strand is self-contained, the curriculum is intentionally designed to support integration and progression across strands. This allows for both horizontal and vertical scaffolding of competencies:

- **Ethics and Inclusion** introduced in **Strand 1** recur in **Strands 4, 5, and 6**, deepening with context (e.g. labour rights, AI risks, green skills).
- **Technical foundations** in **Strand 2** (student) or **Strand 2** (educator) are prerequisites for effective work in **Strands 3 and 4** (simulation design, real-time physics, and custom XR content).

- **Collaboration and user testing** in **Strands 5 and 6** highlight interdisciplinary skills such as teamwork, feedback integration, and co-design, aligning with real-world XR production pipelines.

This integrated model supports:

- **Partial recognition of learning** (per ECVET) through stackable modules
- **Re-entry at higher levels** in different educational settings (e.g., from VET to HEI)
- **Micro-credentialing opportunities**, enabling learners to upskill rapidly or demonstrate specific XR competencies
- **Compliance with EQAVET** [8] through a structure that embeds transparent outcomes, continuous evaluation, and modular improvement.

The Alliance4XR modular framework enables adaptive and scalable curriculum implementation, supporting diverse learner pathways, including lifelong learning and interdisciplinary innovation.

## 3.3 Inclusivity by Design: UDL and Accessibility Principles

As immersive and digital technologies become central to modern education and training, inclusive design is not only a pedagogical priority but a systemic requirement for equity and access. The Alliance4XR curriculum—designed to function across EQF levels 4 to 7 and within diverse formal and non-formal learning settings—positions accessibility and Universal Design for Learning (UDL) as critical to its cross-sectoral, pan-European mission.

UDL, as developed by CAST [3], provides a proactive framework for designing learning environments that anticipate learner variability. Its three core principles—multiple means of representation, action and expression, and engagement—support learner agency and accessibility without the need for retrofitting. These principles are conceptually aligned with the curriculum's pedagogical underpinnings: constructivist learning, experiential education, and the spiral progression model that defines how content is scaffolded across EQF levels. However, while UDL is embedded as a theoretical foundation within the curriculum, it has not yet been comprehensively operationalised in strand delivery models or educator guidance.

In XR contexts, accessibility introduces both novel challenges and unique opportunities. Simulations can exclude users with sensory or mobility impairments if poorly designed, yet they also offer the possibility of personalised, multimodal experiences. D2.1 includes references to ethical and inclusive XR design, particularly in Strand 1 (ethical implications of XR) and Strand 6 (application of ethical frameworks in capstone projects). However, these references must be extended beyond content-level outcomes to affect how learning is delivered, assessed, and supported.

Feedback from the D4.2.1 pilot report reinforced this point. Educators and institutional stakeholders emphasised the need for more structured support in lesson design, learner engagement strategies, and implementation of inclusive practices. The absence of detailed educator guidance, particularly for accommodating different learner levels and needs, emerged as a significant barrier to consistent delivery. As such, integrating UDL into educator-facing resources is now a key priority for the curriculum's next phase of development.

To support future implementation, the following are proposed as UDL-aligned practices for XR-enhanced learning:

- Provide alternative formats for XR activities (e.g. transcripts, captions, visual/audio descriptions).
- Allow for multimodal assessments (e.g. written reports, interactive walkthroughs, annotated simulations).
- Embed keyboard navigation, voice control, and customisation options for XR environments.

Ensure asynchronous access, chat-based participation, and screen-reader compatibility in collaborative tasks.

Moreover, aligning with EQAVET's indicators on access, participation, and learner-centred provision, accessibility and UDL should be part of the curriculum's ongoing evaluation and review cycles. They are not technical add-ons but embedded indicators of educational quality and social responsibility.

In conclusion, accessibility and UDL are integral to the long-term success and impact of the Alliance4XR curriculum and its implementations. Embedding them across strands, assessments, and teaching practices will ensure that XR-enhanced

learning is not only innovative but inclusive, equitable, and aligned with European values of participation, diversity, and lifelong learning.

## 3.4 Assessment and Credit Mapping (EQF/ECVET Integration)

Assessment within the Alliance4XR curriculum plays a foundational role in validating the achievement of learning outcomes across EQF levels 4 to 7. As the curriculum is designed to be modular, stackable, and cross-sectoral, the assessment strategy ensures that learner progress is meaningfully measured and consistently benchmarked against European competence frameworks. Each learning outcome—whether related to foundational knowledge, applied skills, or professional autonomy—is accompanied by assessment criteria appropriate to its EQF level, ensuring that evaluation methods are proportionate, transparent, and pedagogically aligned.

Crucially, the assessment framework supports alignment with both the European Quality Assurance Framework for Vocational Education and Training (EQAVET) and the European Credit System for Vocational Education and Training (ECVET) [10]. This dual alignment guarantees quality, comparability, and portability of learning, enabling learners to accumulate and transfer credits across institutions and national contexts. The curriculum is structured around units of learning outcomes that are assessable, recognisable, and credit-bearing—supporting flexible entry, progression, and re-entry pathways for learners at different stages.

Both formative and summative assessment approaches are embedded across strands. Formative assessment—including reflection, feedback loops, and usability testing—enables continuous learner support and iterative improvement. Summative assessment, such as capstone projects or structured practical evaluations, ensures rigorous demonstration of knowledge and competencies. This blended approach enhances learner agency and supports diverse learning preferences while maintaining validity and reliability. In this way, assessment functions not only as a tool for measuring learning but also as a driver of learning design, inclusive practice, and curricular coherence.

### 3.4.1 Assessment Strategy

The assessment strategy for the Alliance4XR curriculum is explicitly aligned with the modular strand structure and clearly defined learning outcomes. Each strand includes a set of learning outcomes that are mapped to EQF domains—knowledge, skills, and responsibility/autonomy—ensuring consistency with European qualifications frameworks and enabling meaningful progression across EQF Levels 4 to 7. This strand-specific alignment provides clarity for both learners and educators regarding the competencies to be demonstrated at each level.

Assessment rubrics accompany each strand and provide level-appropriate evaluation criteria. These rubrics are grounded in competency-based assessment principles and include descriptors that differentiate expectations across EQF levels. They serve not only to measure performance but also to support learning by providing transparent, actionable feedback. Learners can track their development in relation to knowledge acquisition, technical and practical skills, and the development of responsible, ethical practice within XR environments.

A variety of assessment tools are used to accommodate different learning preferences, institutional contexts, and delivery formats. These include performance-based tasks such as configuring XR systems or developing XR content; capstone projects that synthesise knowledge from multiple strands; scenario-based simulations replicating real-world challenges; portfolio submissions that document learning over time; and peer review activities that foster collaborative reflection. Each tool is chosen for its ability to demonstrate authentic learning in immersive, applied contexts.

The strategy also incorporates formative and summative elements to track progression, guide instruction, and ensure learning outcomes are met. In doing so, it supports portability, transparency, and credit recognition aligned with EQAVET and ECVET principles.

### 3.4.2 EQF Level Differentiation

The Alliance4XR curriculum framework explicitly incorporates the European Qualifications Framework (EQF) level descriptors [8] —Knowledge, Skills, and Responsibility/Autonomy—to differentiate learning expectations and scaffold assessment practices. This differentiation ensures that learning outcomes,

teaching strategies, and assessment rubrics are appropriately aligned across EQF Levels 4 to 7, enabling modular progression and the meaningful recognition of partial learning.

At **EQF Levels 4–5**, the curriculum focuses on foundational knowledge acquisition and the ability to apply standardised procedures in familiar, structured contexts. Learners are assessed on their understanding of XR terminology, system setup, and ethical awareness, with tasks that involve **routine execution of clearly defined activities**. Responsibility is limited to supervised tasks and structured collaboration. For example, in Strand 2 (XR Hardware and Software), a Level 5 learner might demonstrate the ability to install XR devices and troubleshoot issues using predefined protocols, supported by task-based checklists and formative observation.

At **EQF Level 6**, the emphasis shifts towards **complex problem-solving, applied technical skills, and independent project planning**. Learners are expected to synthesise knowledge from multiple strands, select appropriate tools for context-specific problems, and take ownership of project implementation. In Strand 4 (XR Applications Across Industries), for instance, a Level 6 learner might design a sector-specific XR simulation, justify tool selection, and conduct iterative testing. Assessments include scenario-based projects and reflective reports, highlighting the learner's decision-making and accountability.

At **EQF Level 7**, the curriculum introduces expectations of **innovation, leadership, and critical engagement with uncertain or interdisciplinary challenges**. Learners are required to demonstrate originality in applying knowledge, critique ethical frameworks, and lead collaborative XR design processes. In Strand 6 (Capstone), for example, a Level 7 student might lead a cross-functional team to develop a fully operational XR prototype addressing a real-world problem, integrating ethical, accessibility, and sustainability dimensions. Assessment at this level includes peer-reviewed portfolios, high-stakes presentations, and evaluative reports addressing both technical and societal implications.

This EQF-based scaffolding ensures transparency, comparability, and learner mobility across education systems. It also allows for customisation of micro-

credentials and supports upskilling pathways for learners entering the curriculum at different stages or with varied prior experience.

### 3.4.3 ECVET Credit Mapping

The Alliance4XR curriculum framework adopts a modular structure that facilitates clear alignment with the European Credit System for Vocational Education and Training [5]. This alignment enables the curriculum to support learner mobility, transparency of learning outcomes, and recognition of partial qualifications across sectors and national systems. Through the use of defined units of learning outcomes, the framework allows for the allocation of ECVET credit points based on estimated learner workload and supports the flexible design of learning pathways and micro-credentials.

Each of the curriculum strands — across both student and educator pathways — is subdivided into units of learning outcomes. A typical unit encompasses a single strand learning outcome, or a closely related group of outcomes, bundled for coherence in teaching, learning, and assessment. These units are developed with the following core components:

- **Clearly defined learning outcomes (LOs):** Each unit identifies what a learner is expected to know, understand, or be able to do upon completion. These are mapped to EQF levels and expressed using action verbs consistent with Bloom's Taxonomy.
- **Assessment criteria:** Units include strand-specific, EQF-aligned rubrics that describe how performance will be measured. These criteria are competency-based and span domains of knowledge, skills, and responsibility/autonomy.
- **Workload estimation:** Each unit is assigned a notional workload based on the learner time required to acquire the competencies. Following ECVET guidance, **one credit typically represents 25–30 hours** of learner effort, including instruction, practice, and assessment activities.

For example, Strand 2 (XR Hardware and Software Setup) includes the unit: "Demonstrate setup and troubleshooting of XR classroom tools." This may be estimated at 30 hours and assigned 1 ECVET credit, with assessment based on a performance task and reflective commentary.

The modularisation of learning outcomes also supports the development and issuing of micro-credentials. These can be awarded for:

Single-unit completions: such as mastering the setup of XR tools (Strand 2.1) or designing an ethical XR teaching scenario (Strand 5.4).

Cross-strand modules: such as a thematic micro-credential on "XR Ethics and Accessibility," which might draw from Strand 1 (ethical implications), Strand 3 (inclusive pedagogy), and Strand 5 (evaluation and reflection).

This flexible approach is designed to enable VET institutions and HEIs to construct programmes aligned with sector needs and learner progression goals. Learners can accumulate and transfer ECVET credits toward formal qualifications or CPD recognition, and institutions can stack units into full modules, diplomas, or bespoke training packages. Furthermore, the ECVET-compatible structure supports the implementation of quality assurance mechanisms in line with EQAVET. Assessment rubrics, workload documentation, and unit descriptors make the curriculum framework interoperable and adaptable for cross-border recognition and lifelong learning pathways.

As has been evidenced here, ECVET credit mapping in the Alliance4XR curriculum framework supports modularity, transparency, and learner-centred design making it a robust tool for recognition of both formal and non-formal XR learning across Europe.

### 3.4.4 Capstone Integration

The capstone projects embedded in the Alliance4XR curriculum represent a critical synthesis point where learning across multiple strands converges into a final demonstrable output. They are designed not only as summative assessments but as reflective, learner-led activities that align with higher-level EQF descriptors (Levels 6–7), particularly in domains of autonomy, responsibility, and critical integration of knowledge and skills. Crucially, both student and educator capstone pathways are constructed with Universal Design for Learning (UDL) principles to ensure inclusivity, adaptability, and learner agency.

#### 3.4.4.1 Student Curriculum: Strand 6 – Capstone Project

In the student curriculum, **Strand 6: Capstone Project** calls on learners to design, develop, and evaluate a fully functional XR application that addresses a real-world problem. This is not merely a technical exercise; it represents the culmination of competence developed across all previous strands:

- **Strand 1**: Conceptual grounding in XR and its ethical implications.
- **Strand 2**: Technical setup and platform fluency.
- **Strand 3 and 4**: Domain-specific content development.
- **Strand 5**: Collaborative and social design.

The capstone requires learners to:

- Define a project challenge with real-world relevance;
- Build an XR prototype or simulation, showing mastery of technical and design tools;
- Conduct user testing and analysis, gathering both quantitative and qualitative feedback;
- Deliver a reflective report, including critical evaluation of their design, ethical implications (e.g. privacy, inclusion, green skills), and technical problem-solving processes;
- Present and defend their work in a structured peer or expert review session.

To honour the diversity of learners and support flexibility, the capstone assessment framework applies **UDL principles**:

- Learners can present their outputs in **multiple modalities**: e.g. written reports, narrated videos, live demonstrations, or digital portfolios.
- Instructions and criteria are made available in **accessible formats**, including screen-reader-friendly text, visual aids, and guided templates.
- Assessment rubrics accommodate differentiated evidence of learning, allowing for strengths in applied skills, critical reflection, or innovation to be equally valued.

This ensures that the capstone process validates not just a technical output but the full spectrum of learner capacities.

#### 3.4.4.2 Educator Curriculum: Strand 5 – Evaluating and Improving XR-Enhanced Teaching

In the educator curriculum, the equivalent capstone appears in **Strand 5**, where educators are assessed on their ability to apply XR technologies in pedagogically sound, inclusive, and ethically grounded ways.

Educators are required to:

- Design and deliver a sequence of XR-enhanced learning experiences aligned with identified learning outcomes
- Gather and analyse student engagement and performance data, using evidence to evaluate effectiveness
- Critically reflect on pedagogical, ethical, and accessibility issues in the design and delivery process
- Present their findings to peers for feedback and professional discussion

The assessment approach models best practices in experiential learning and UDL:

- Educators may use lesson walkthroughs, annotated materials, or student artefacts as evidence
- Reflections can be submitted in multiple formats (e.g. audio, video, or written)
- Peer feedback is structured to promote collaborative professional development

Just as students are assessed on technical and ethical competence, educators are assessed on instructional design, learner support, and responsiveness to diversity, reflecting their dual role as practitioners and pedagogical leaders.

### 3.4.5 Alignment with EQF and ECVET

Capstone tasks are aligned with EQF levels 6–7 in that they require independent problem-solving, integration of diverse knowledge areas, and the ability to manage unpredictable and complex contexts. The assessment rubrics used are EQF-sensitive, distinguishing expectations across knowledge, skills, and responsibility/autonomy domains.

Moreover, these capstone projects support ECVET-based validation by serving as units of learning outcomes that integrate multiple strands. For example, a learner's capstone output might simultaneously demonstrate:

- Knowledge of XR ethics (Strand 1)
- Skill in collaborative design (Strand 5)
- Application of XR for a sector-specific solution (Strand 4)

This multidimensional integration means capstones can accumulate credits across strands and be recognised as composite evidence for micro-credentials or credit transfer. This is particularly valuable in contexts of lifelong learning, upskilling, or cross-border education.

The capstone structure is more than a project, it is a pedagogical and quality assurance mechanism that brings together experiential learning, spiral curriculum design, and EQAVET/ECVET-aligned assessment. It validates not only what learners know but what they can do and how they reflect upon that doing across modalities, disciplines, and learner types. Through the use of UDL, it guarantees that this validation process remains equitable, learner-centred, and adaptable to the needs of diverse education and training systems.

### 3.4.6 Recognition and Progression

The Alliance4XR curriculum is explicitly designed to promote learner progression and recognition across education and training systems through its modular, outcomes-based structure. Each of the six strands operates as a self-contained unit of learning, aligned to EQF levels 4 through 7, allowing for seamless credit accumulation and transfer across multiple learning contexts including VET, HEI, and CPD initiatives.

#### 3.4.6.1 Credit Transfer and Modular Flexibility

By anchoring all learning outcomes to EQF domains (Knowledge, Skills, Responsibility/Autonomy) and by referencing ECVET principles, the curriculum supports recognition of prior learning (RPL) and credit portability. Learners may progress from short-term learning activities or micro-credentials toward full qualifications by combining units across strands. Similarly, learners from formal education or the workplace can re-enter education at an appropriate EQF level without repeating prior learning. This is crucial for promoting lifelong learning and enabling individuals to build flexible, personalised learning pathways.

For example:

- A VET learner completing Strands 1 (Introduction), 2 (Hardware), and 4 (Industry Applications) at EQF Level 5 can transfer credits toward a HEI programme that begins at Level 6 with Strand 3 (Applied Development).
- An educator completing CPD through Strand 2 (Hardware Setup) and Strand 3 (Pedagogical Strategies) can later pursue a full teaching qualification by adding Strand 5 (Evaluation) and Strand 6 (Capstone Design).

#### 3.4.6.2 Cross-System and Cross-Border Recognition

The curriculum is designed to be interoperable with national qualification frameworks and existing institutional credit systems. Its alignment with the European Qualifications Framework (EQF) ensures relevance across EU countries, while its modular structure lends itself to recognition under European national qualifications systems.

The use of learning outcomes and assessment rubrics enables institutions to map course content transparently and consistently, facilitating mutual recognition agreements between providers and national authorities.

#### 3.4.6.3 Digital Credentialing and Europass

To further support recognition and learner mobility, the Alliance4XR curriculum is designed to interface with Europass and the Europass Digital Credentials Infrastructure (EDCI). Digital credentials issued through EDCI allow for:

- Secure, portable proof of achievement
- Inclusion of detailed metadata (EQF level, workload, assessment method, issuing authority)
- Interoperability across systems and borders

These credentials can be awarded for:

- Full strand completion (e.g. XR Content Creation at EQF Level 6)
- Capstone project outcomes (integrating multiple strands)

Bespoke micro-credentials designed by institutions or consortia

**Progression Pathways**

The curriculum also supports **vertical progression** (e.g. EQF Level 5 to 6), **horizontal movement** (e.g. across sectors or from technical to pedagogical roles), and **diagonal learning** (e.g. combining technical and ethical dimensions). Its flexibility supports diverse learner goals, including:

- Formal qualifications (certificates, diplomas, degrees)
- Industry-recognised micro-credentials
- Targeted upskilling in green and digital skills for professional development

This design ensures that learners are not constrained by institutional boundaries, and that learning is recognised, valued, and transferable, supporting the overarching goals of the European Education Area and the Digital Education Action Plan.

# 4. CURRICULUM IMPLEMENTATION AND COURSE DESIGN

This section supports the practical rollout of the Alliance4XR curriculum across a range of educational settings. It serves as a bridge between the curriculum framework and its real-world application in vocational education, higher education, and professional development contexts. The section provides guidance on how to translate strand-based learning outcomes into coherent, learner-centred courses that reflect pedagogical best practices and European quality standards.

Course designers and educators are supported in developing modular learning experiences that accommodate a variety of learner profiles, including those with different levels of prior knowledge, professional goals, and learning needs. The section offers examples of how strands can be assembled into full programmes or shorter courses for both students and educators, with alignment to EQF levels 4–7. These examples illustrate how to build learner progression through scaffolding, spiral learning, and experiential engagement.

XR technology integration is addressed as a key delivery consideration. The section explores different models for using XR in learning environments, ranging from fully immersive labs to blended or remote delivery. It provides guidance for working with the Alliance4XR platform, enabling cross-institutional collaboration and

shared access to resources. In line with Universal Design for Learning (UDL), recommendations are also given to ensure XR experiences are accessible and inclusive.

The assessment strategy is discussed in relation to credit recognition and learner mobility. Tools such as performance tasks, portfolios, and capstone projects are linked to ECVET-compatible micro-credentials. The section also outlines how these assessments contribute to credit accumulation, transfer, and recognition through platforms like Europass and the EDCI. These pathways support both short-term upskilling and longer-term qualification progression.

Together, this section ensures the curriculum is ready to be implemented flexibly, inclusively, and effectively across European learning systems.

## 4.1 Designing Learner-Focused Courses (Students and Educators)

The Alliance4XR curriculum is structured to support flexible, modular course design that can be adapted by VET providers, higher education institutions (HEIs), and continuing professional development (CPD) centres. This section provides guidance on assembling curriculum strands into coherent and outcome-driven learning experiences, enabling tailored delivery across EQF levels 4 to 7 for both student and educator audiences.

Course designers can select and sequence strands based on learner profiles, institutional goals, and sectoral priorities. For example, a VET course at EQF level 5 might combine Strand 1 (Introduction to XR Technologies), Strand 2 (XR Hardware and Software Setup), and Strand 4 (XR Across Industries) to offer practical, industry-focused skills. Conversely, an HEI module at EQF level 7 might integrate Strand 3 (XR for Engineering and Applied Sciences), Strand 5 (Collaborative XR), and Strand 6 (Capstone) to foster interdisciplinary problem-solving and innovation.

Curriculum templates and pathway planners support different modes of engagement: full programme design, short courses for targeted upskilling, or micro-credentials drawing from individual or cross-strand learning outcomes. These options allow institutions to cater to diverse learner needs while ensuring alignment with ECVET credit structures and recognition mechanisms.

Learner-centred course design must also address pedagogical fit. Teaching and assessment methods should reflect the EQF level of the learners—scaffolding foundational knowledge at EQF 4–5, while promoting critical thinking, autonomy, and innovation at EQF 6–7. Experiential learning and project-based activities are recommended across levels, supported by constructivist and spiral pedagogies.

Finally, coherence between student and educator pathways is crucial. Educator training programmes should not only mirror student competencies but also extend them through pedagogical integration. For instance, both groups engage in ethical evaluation, but educators also explore how to facilitate these discussions with learners. Capstone projects (Strand 6 for students, Strand 5 for educators) offer shared grounding in reflective, applied practice, reinforcing a whole-system approach to XR teaching and learning.

By following these design principles, institutions can ensure that Alliance4XR courses are responsive, inclusive, and pedagogically robust—ready to support Europe's digital and green skills transition.

## 4.2 XR Delivery Models and Platform Integration

The Alliance4XR curriculum is designed to be delivered through flexible and inclusive XR modalities that reflect real-world constraints and opportunities across educational settings. This section outlines different XR delivery models, infrastructure considerations, and the role of the Alliance4XR platform in supporting scalable, accessible, and pedagogically sound integration.

**Delivery Models**

XR teaching and learning can be implemented through a range of delivery modes, allowing institutions to choose approaches that match their technical capacity, learner needs, and curricular goals:

- **Fully Immersive**: In-person sessions using head-mounted displays (HMDs) and motion tracking for rich, embodied simulations.
- **Blended XR**: Combining traditional instruction with XR experiences that enhance specific topics or skills.
- **Desktop Simulation**: Using WebXR or 3D content on PCs/tablets to simulate environments without full immersion.

- **Remote-Access XR**: Cloud-based delivery enabling learners to participate in XR activities from home or distributed sites.

**Infrastructure Requirements**

To support these models, institutions need:

- Appropriate hardware (HMDs, hand controllers, compatible computers).
- Reliable connectivity for high-bandwidth XR applications.
- Safe physical space for movement-based XR activities.
- Security protocols for device sharing and data protection.

**Platform Integration**

The **Alliance4XR platform** plays a central role in hosting and managing learning content. It provides:

- Access to shared XR assets, lesson templates, and teaching resources.
- Tools for collaborative development and peer review across institutions.
- Learner progress tracking and portfolio management features.
- Compatibility with standards for credentialing (e.g., Europass, EDCI).

**Accessibility and UDL**

Inclusive delivery is a core design principle. XR experiences must accommodate diverse user needs by offering:

- Alternative formats (e.g., video walkthroughs, 2D modes, captioned content).
- Screen reader compatibility and keyboard navigation where applicable.
- Customisable interfaces (e.g., motion sensitivity controls, font scaling).
- Modular content sequencing to allow for varied learning speeds and pathways.

**Educator Preparation**

Effective XR integration requires trained educators. The curriculum includes dedicated training strands that cover:

- Technical onboarding to the Alliance4XR platform.
- Pedagogical strategies for XR-enhanced teaching.
- Scenario-based training modules to build educator confidence and competence in immersive learning environments.

By accommodating multiple delivery models and embedding UDL principles, the curriculum ensures equitable and effective XR learning across a range of contexts and institutions.

## 4.3 Assessment Tools, Micro-credentials, and Recognition Pathways

The Alliance4XR curriculum embeds assessment as an integral part of course design and delivery. It ensures that learners' achievements are measured accurately, recognised transparently, and made portable across educational systems and career pathways. The assessment framework supports both formative and summative approaches, aligned with EQF level descriptors and ECVET principles to foster learner progression and recognition of prior or partial learning.

Each strand within the curriculum includes assessment rubrics designed to evaluate strand-specific learning outcomes across the EQF domains of Knowledge, Skills, and Responsibility/Autonomy. Tools used across levels include:

- **Formative assessments**: reflective journals, peer reviews, checkpoint quizzes, and observation during practice-based sessions to guide feedback and learning progression.
- **Summative assessments**: scenario-based simulations, practical tasks, capstone projects, and portfolio submissions to validate comprehensive understanding and applied competence.

Assessment strategies are scaffolded according to EQF levels:

- EQF 4–5: Focus on accurate execution of routine tasks, demonstration of foundational skills, and adherence to given instructions.
- EQF 6: Emphasis on independent application of knowledge, problem-solving in complex contexts, and integration of ethical frameworks.
- EQF 7: Learner-led innovation, critical evaluation, and leadership in interdisciplinary and unpredictable situations.

Alliance4XR enables the design and issuance of modular micro-credentials that correspond to individual strands or integrated learning units. Each micro-credential includes:

- Clearly defined learning outcomes.

- Assessment criteria and performance benchmarks.
- Estimated learner workload (typically 25–30 hours per 1 ECVET credit).
- Embedded metadata compatible with the Europass Digital Credentials Infrastructure (EDCI).

These micro-credentials support:

- Stackable progression within longer learning pathways.
- Partial recognition of prior or continuing education achievements.
- Flexibility for re-entry into education after interruptions or for upskilling/reskilling purposes.
- Cross-sector and cross-border portability, especially relevant in XR-related industries where standardised skills recognition supports mobility and labour market integration.

The modular structure allows learners to:

- Accumulate credits across multiple providers (e.g., VET to HEI progression).
- Transition between formal education and continuing professional development (CPD).
- Customise learning journeys according to their professional needs, with transparent validation at each stage.

The Alliance4XR assessment and credentialing framework not only verifies what learners know and can do, but also supports equity, flexibility, and lifelong learning, all while maintaining alignment with EQAVET, ECVET, and Europass standards.

## 4.4 Resource Bank Development and Strand-Level Materials

Task 2.1 of the Alliance4XR project was responsible for the initial development of the curriculum framework. This included the definition of six core curriculum strands for both student and educator pathways. Each strand was structured around clearly articulated learning outcomes aligned with the European Qualifications Framework (EQF) from Levels 4 to 7. These strands were informed by labour market needs, pedagogical research, and sectoral priorities outlined in

the project proposal, including applications in structural engineering, energy and grids, and maritime professions.

Building on this foundational work, Task 2.2 focused on the development of strand-specific teaching and training materials. This task involved organising Alliance4XR partners to contribute example materials corresponding to each strand and learning outcome. The collection of syllabi includes PowerPoint presentations, and lesson templates developed by individual partners. These materials were assembled into a resource bank (refer to Appendix E), with content tagged by strand and contributor, offering a preliminary step toward practical implementation. This resource bank will be fine-tuned and referenced to EQF levels in the next phase, the 2nd version of the Teaching and Training Material.

**Next Steps for Enhancing the Strand-Specific Resource Bank**

To ensure the contributed materials are usable, inclusive, and aligned with the goals of the Alliance4XR curriculum, the following steps are recommended:

1. **Conduct a Quality Assurance Review:** Evaluate the completeness, consistency, and pedagogical soundness of the submitted resources to ensure they meet baseline standards for educational use.
2. **Ensure EQF-Level Annotation**: Annotate relevant resources with the relevant EQF level(s) it supports, based on learning outcome alignment and instructional complexity.
3. **Integrate Accessibility and UDL Principles**: Review and revise materials to ensure compatibility with Universal Design for Learning (UDL) guidelines and accessibility standards, supporting inclusive education across all contexts.
4. **Align with Assessment Criteria**: Map relevant resources to associated assessment rubrics and performance criteria to support learning validation and outcome-based instruction.
5. **Develop a Clear Indexing and Tagging System**: Catalogue materials according to strand, learning outcome, contributor, target audience (e.g., sector, student or educator), and EQF level to facilitate modular reuse and navigation.

6. **Package Resources into Modular Learning Units**: Organise materials into coherent learning units or modules that can be adapted for use in full programmes, short courses, or micro-credentials.
7. **Create Accompanying Guidance Notes**: Provide short instructional guides for resource/s or module, explaining suggested use cases, required technologies, and pedagogical objectives.

# 5. MONITORING AND EVALUATION

Effective monitoring and evaluation (M&E) are central to ensuring that the Alliance4XR curriculum remains responsive, high-quality, and fit for purpose. Guided by the EQAVET quality assurance cycle—Planning, Implementation, Evaluation, and Review—this section outlines how performance is tracked, how feedback is gathered from stakeholders, and how iterative quality improvement is enacted. The focus is not only on learning outcomes but also on the processes, tools, and structures supporting successful curriculum implementation.

## 5.1 Key Performance Indicators (EQAVET-Linked)

The following Key Performance Indicators (KPIs) are aligned with EQAVET indicators and mapped to the intended outcomes of the Alliance4XR curriculum:

- **Curriculum Uptake and Delivery**
    - Number of institutions implementing the curriculum across VET, HE, and CPD sectors.
    - Number of students and educators enrolled in XR-based modules.
- **Learning Outcomes Achievement**
    - Percentage of learners achieving defined learning outcomes per strand.
    - Completion rates for micro-credentials and capstone projects.
- **Progression and Employability**
    - Percentage of learners progressing to higher EQF levels.
    - Learner transitions to employment or further study in XR-related sectors.
- **Inclusivity and Accessibility**

    - Percentage of XR resources meeting UDL and accessibility standards.
    - Learner feedback scores on inclusion and usability.
- **Recognition and Portability**
    - Number of ECVET-aligned micro-credentials issued.
    - Use of Europass Digital Credentials for recognition.

These indicators are collected through standardised reporting templates, assessment records, user analytics from the Alliance4XR platform, and partner self-assessments.

## 5.2 Stakeholder Feedback and Lessons from Piloting

Piloting activities conducted as part of D4.2 offered direct insights from VET and HE institutions, educators, and learners involved in early implementation. Key lessons included:

- **Need for contextual clarity**: Users requested clearer mapping of curriculum materials to learner levels and sector-specific contexts.
- **Stronger delivery guidance**: Institutions reported the need for examples of teaching strategies and assessment activities.
- **Platform usability**: Some technical barriers were noted in accessing XR tools, highlighting the importance of onboarding and technical support.

As a result of this feedback:

- Curriculum templates and EQF-aligned rubrics have been revised.
- Additional educator resources and case studies have been developed.

Strand-level assessment guidance has been clarified and modularised.

## 5.3 Quality Assurance Feedback

Internal and external review mechanisms support ongoing curriculum improvement:

- **Internal QA** is ensured through partner collaboration, iterative development cycles, and alignment with EQAVET indicators.
- **External QA** involves expert reviews, alignment checks against EU frameworks (EQF, ECVET, UDL), and continuous validation by pilot site partners.

Feedback loops are formalised through:

- Curriculum review workshops.
- Structured surveys from students, educators, and institutional leaders.
- Analysis of learner performance data and capstone assessment outputs.

Together, these monitoring and evaluation processes ensure that the Alliance4XR curriculum is not static but dynamically responsive, adapting to user needs, evolving technologies, and changing labour market requirements.

# 6. RECOMMENDATIONS AND FUTURE DIRECTIONS

This section outlines key recommendations and strategic considerations to guide the ongoing refinement, implementation, and sustainability of the Alliance4XR curriculum. Building directly upon insights and feedback gathered during the development of this deliverable (D2.2), these recommendations will inform the next iteration of curriculum materials in deliverable **D2.3: Final Version of Teaching and Training Curricula**. Emphasis is placed on ensuring continued alignment with industry needs, robust pedagogical approaches, scalability across institutional contexts, and sustainable integration into broader educational and policy frameworks.

The recommendations are organised into four key areas of focus to provide clear direction and practical steps for the project's next phases: curriculum refinement and iterative development, pilot preparation and feedback collection, scaling and policy integration, and sustainability planning. Each area outlines actions that will strengthen both the immediate implementation and long-term viability of the curriculum, reinforcing its relevance and adaptability across sectors, EQF levels, and educational settings.

## 6.1 Curriculum Refinement and Iterative Development

To ensure continuous relevance and responsiveness to industry and learner needs, the following recommendations for curriculum refinement are proposed:

- **Explicit Integration of Industry Use-Case:**

  Clearly embed detailed XR scenarios and industry-relevant examples (structural engineering, energy and grids, maritime professions) within

curriculum strands, learning outcomes, instructional resources, and assessment tasks. This includes developing illustrative case studies, scenario-based assessments, and practical activities explicitly linked to these sectors.

- **Strengthened Alignment with EQF, ECVET, and EQAVET**

  Further refine modular learning outcomes and clearly articulate assessment criteria at each EQF level, ensuring transparency and ease of credit transfer across institutional and national boundaries.

- **Enhanced Pedagogical Clarity**

  Provide detailed pedagogical guidance, especially in experiential learning methodologies, constructivist practices, and Universal Design for Learning (UDL), including practical examples and instructional scenarios.

## 6.2 Preparing for Pilot Implementation

The upcoming pilot phase will test and validate the curriculum across diverse educational contexts. Key steps for preparation include:

- **Pilot Partner Engagement**

  Develop detailed implementation guides and comprehensive onboarding resources for pilot institutions, explicitly detailing XR hardware/software requirements, accessibility considerations, and pedagogical methods.

- **Capacity Building for Educators**

  Conduct structured professional development workshops and provide access to curated educator training materials, ensuring educators are prepared to deliver XR-enhanced learning.

- **Feedback and Data Collection Mechanisms**

  Implement clear procedures for systematically collecting learner and educator feedback, assessment data, and usability insights from pilot activities to inform subsequent curriculum iterations.

## 6.3 Scaling, Transferability, and Policy Integration

To ensure broad uptake and long-term integration of the Alliance4XR curriculum, the following strategic recommendations are highlighted:

- **Thematic Modular Design for Industry-Specific Application**

  Create clearly defined thematic modules or micro-credentials targeting specific sectors (structural engineering, energy and grids, maritime professions). Align these explicitly with EQF descriptors and ECVET credits, facilitating sector-specific career pathways and transferability of credentials.

- **Recognition Pathways and Credit Portability**

  Clearly document recognition pathways, including explicit scenarios demonstrating cross-sectoral credit transfer, to strengthen institutional buy-in and learner mobility. Use Europass Digital Credentials Infrastructure (EDCI) for issuing micro-credentials.

- **Policy and Institutional Integration**

  Engage proactively with policymakers and qualification authorities at national and European levels to embed XR competencies within broader frameworks and funding structures, ensuring long-term policy support and institutional adoption.

**Next Steps and Sustainability Plan**

To ensure the curriculum's sustainability and continued relevance beyond the project timeline, the following actions are recommended:

- **Capstone Projects Anchored in Industry Needs**

  Embed industry-linked capstone projects at EQF Levels 6–7, explicitly requiring learners to address real-world challenges and innovations within the structural engineering, energy and grids, and maritime sectors, thereby ensuring direct alignment with industry competencies.

- **Platform Development and Technical Scalability**

Clearly define further development phases of the Alliance4XR digital platform, specifying enhancements such as advanced tracking, analytics, and collaborative functionality to support scaling across institutions.

- **Continuous Quality Assurance**

  Establish ongoing curriculum review cycles, informed by EQAVET indicators, incorporating feedback loops from learners, educators, industry partners, and external evaluators. Ensure curriculum updates remain adaptive to technological advancements and evolving industry needs.

- **Community of Practice and Dissemination**

  Foster an active community of practice among educators, institutions, and industry stakeholders, supported by regular dissemination events, workshops, and the publication of best practice guides.

These structured recommendations collectively support the ongoing improvement, scaling, and long-term sustainability of the Alliance4XR curriculum, ensuring it remains pedagogically robust, industry-relevant, and strategically aligned with broader educational and labour market needs.

# 7. BIBLIOGRAPHY

[1] Biggs, J., Tang, C., & Kennedy, G. (2022). *Teaching for Quality Learning at University 5e*. McGraw-Hill Education (UK).

[2] Bruner, J. S. (1960). *The Process of Education*. Harvard University Press. https://books.google.gr/books?id=Iaq5R8vPujAC

[3] CAST. (2018). *The UDL Guidelines*. https://udlguidelines.cast.org

[4] *Defining, writing and applying learning outcomes | CEDEFOP*. (2017, November 8). https://www.cedefop.europa.eu/en/publications/4156

[5] *ECVET*. (2009). https://www.cedefop.europa.eu/en/projects/european-credit-system-vocational-education-and-training-ecvet

[6] *EDCI Standards | Europass*. (2025). https://europass.europa.eu/en/edci-standards

[7] *EQAVET*. (2020). https://employment-social-affairs.ec.europa.eu/policies-and-activities/skills-and-qualifications/working-together/eqavet-european-quality-assurance-vocational-education-and-training_en

[8] *EQAVET*. (2025, June 20). https://employment-social-affairs.ec.europa.eu/policies-and-activities/skills-and-qualifications/working-together/eqavet-european-quality-assurance-vocational-education-and-training_en

[9] European Commission. (2008). *Recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning (Text with EEA relevance)*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=oj:JOC_2008_111_R_0001_01

[10] European Commission. (2009). *Recommendation of the European Parliament and of the Council of 18 June 2009 on the establishment of a European Credit System for Vocational Education and Training (ECVET)Text with EEA relevance*.

[11] *Future of Education and Skills 2030/2040*. (2019). OECD. https://www.oecd.org/en/about/projects/future-of-education-and-skills-2030.html

[12] Kolb, D. A. (2015). *Experiential Learning: Experience as the Source of Learning and Development*. Pearson Education, Incorporated. https://books.google.gr/books?id=o6DfBQAAQBAJ

[13] Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented reality: A class of displays on the reality–virtuality continuum. Proceedings of Telemanipulator and Telepresence Technologies, 2351, 282–292. https://doi.org/10.1117/12.197321

[14] Moon, J. (2002). *The Module and Programme Development Handbook A Practical Guide to Linking Levels, Outcomes and Assessment Criteria*. Routledge.

[15] Piaget, J. (1950). *The Psychology of Intelligence*. Routledge, Taylor and Francis Group.

[16] Piaget, J. (1952). *The origins of intelligence in children*. (M. Cook, Trans.). W. W. Norton & Company.

[17] Vygotsky, L. S., & Cole, M. (1978). *Mind in Society: Development of Higher Psychological Processes*. Harvard University Press. https://books.google.gr/books?id=RxjjUefze_oC

# 8. APPENDICES

## Appendix A: Student Competency-Based Assessment Rubric (EQF 4–7)

| Strand | LO ID | Description | EQF Level | EQF Domain | Performance Descriptor |
|---|---|---|---|---|---|
| **Strand 1: Introduction to XR Technologies** | S1.1 | 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. | EQF 4 | Knowledge | Basic factual knowledge of a field of work or study |
| **Strand 1: Introduction to XR Technologies** | S1.2 | Describe the historical development and future trends in XR technology. | EQF 4 | Knowledge | Basic factual knowledge of a field of work or study |
| **Strand 1: Introduction to XR Technologies** | S1.3 | Identify key hardware and software components used in XR environments. | EQF 4 | Knowledge | Basic factual knowledge of a field of work or study |

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| **Strand 1: Introduction to XR Technologies** | S1.4 | Recognise the ethical implications of XR, including privacy concerns, health and safety risks of XR, and social implications. | EQF 5 | Responsibility and Autonomy | Exercise management and supervision in contexts of work or study activities |
| **Strand 2: XR Hardware and Software Setup** | S2.1 | Demonstrate the ability to set up, configure, and troubleshoot XR hardware (headsets, AR devices, motion tracking systems, etc.). | EQF 4 | Skills | A range of cognitive and practical skills to complete tasks and solve routine problems |
| **Strand 2: XR Hardware and Software Setup** | S2.2 | Compare different XR platforms and development tools (e.g. Alliance4XR, Unity, Unreal Engine, WebXR). | EQF 5 | Knowledge | Comprehensive, specialised, factual and theoretical knowledge within a field |
| **Strand 2: XR Hardware and Software Setup** | S2.3 | Apply basic programming concepts in XR environments to create interactive elements. | EQF 5 | Skills | A comprehensive range of cognitive and practical skills to develop creative solutions |
| **Strand 2: XR Hardware and Software Setup** | S2.4 | Assess the privacy risks associated with data collection in XR devices and propose leading practices for responsible use. | EQF 5 | Responsibility and Autonomy | Exercise management and supervision in contexts of work or study activities |

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| **Strand 3: XR Development for Engineering and Applied Sciences** | S3.1 | Utilise 3D modelling tools to create assets for XR applications. | EQF 5 | Skills | A comprehensive range of cognitive and practical skills to develop creative solutions |
| **Strand 3: XR Development for Engineering and Applied Sciences** | S3.2 | Develop interactive XR simulations for engineering and applied science applications. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 3: XR Development for Engineering and Applied Sciences** | S3.3 | Implement real-time physics and spatial interactions within XR environments. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 3: XR Development for Engineering and Applied Sciences** | S3.4 | Analyse ethical considerations in XR engineering applications, including safety, accessibility, inclusivity in virtual spaces and the impact of GenAI. | EQF 6 | Responsibility and Autonomy | Manage complex technical or professional activities or projects |

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| **Strand 4: Advanced XR Applications Across Industries** | S4.1 | Apply XR solutions to specific industry needs (including structural engineering, energy and grids, and the maritime sector). | EQF 5 | Skills | A comprehensive range of cognitive and practical skills to develop creative solutions |
| **Strand 4: Advanced XR Applications Across Industries** | S4.2 | Design scenario-based training simulations that mirror real-world job environments. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 4: Advanced XR Applications Across Industries** | S4.3 | Optimise user interaction and experience design for different audiences. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 4: Advanced XR Applications Across Industries** | S4.4 | Evaluate ethical challenges in industry-specific XR implementations, such as data security and digital labour rights in virtual workspaces. | EQF 6 | Responsibility and Autonomy | Manage complex technical or professional activities or projects |
| **Strand 5: Collaborative and Multi-User XR Environments** | S 5.1 | Create multi-user XR experiences that support real-time interaction and collaboration. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |

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| **Strand 5: Collaborative and Multi-User XR Environments** | S5.2 | Use networking technologies to facilitate shared virtual spaces. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 5: Collaborative and Multi-User XR Environments** | S5.3 | Develop social XR applications that encourage effective communication and engagement. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 5: Collaborative and Multi-User XR Environments** | S5.4 | Address cybersecurity and user safety concerns in networked XR environments. | EQF 6 | Responsibility and Autonomy | Manage complex technical or professional activities or projects |
| **Strand 6: Capstone Project – Ethical and Practical XR Solutions** | S6.1 | Design and develop a fully functional XR application addressing a real-world problem. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |

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| **Strand 6: Capstone Project – Ethical and Practical XR Solutions** | S6.2 | Integrate ethical frameworks into the project development process, ensuring responsible innovation including green skills. | EQF 7 | Responsibility and Autonomy | Take responsibility for contributing to professional knowledge and practice |
| **Strand 6: Capstone Project – Ethical and Practical XR Solutions** | S6.3 | Conduct user testing and feedback analysis to improve XR usability and accessibility. | EQF 7 | Skills | Specialised problem-solving skills in research and/or innovation |
| **Strand 6: Capstone Project – Ethical and Practical XR Solutions** | S6.4 | Present findings in a professional demonstration and written report, detailing technical execution and ethical considerations. | EQF 7 | Skills | Specialised problem-solving skills in research and/or innovation |

## Appendix B: Educator Competency-Based Assessment Rubric (EQF 4–7)

| Strand | LO ID | Description | EQF Level | EQF Domain | Performance Descriptor |
|---|---|---|---|---|---|
| **Strand 1: Introduction to XR in Education** | E 1.1 | Explore the pedagogical potential of XR technologies in education. | EQF 5 | Knowledge | Comprehensive, specialised, factual and theoretical knowledge within a field |
| **Strand 1: Introduction to XR in Education** | E 1.2 | Compare different learning theories related to immersive learning. | EQF 5 | Knowledge | Comprehensive, specialised, factual and theoretical knowledge within a field |
| **Strand 1: Introduction to XR in Education** | E 1.3 | Identify challenges in XR adoption for teaching and propose solutions. | EQF 5 | Knowledge | Comprehensive, specialised, factual and theoretical knowledge within a field |
| **Strand 1: Introduction to XR in Education** | E 1.4 | Discuss ethical considerations in XR-enhanced learning including privacy, inclusion, and GenAI. | EQF 5 | Responsibility and Autonomy | Exercise management and supervision in contexts of work or study activities |
| **Strand 2: Understanding XR Hardware and Software for Teaching** | E 2.1 | Demonstrate setup and troubleshooting of XR classroom tools. | EQF 5 | Skills | A comprehensive range of cognitive and practical skills to develop creative solutions |

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| **Strand 2: Understanding XR Hardware and Software for Teaching** | E 2.2 | Evaluate platform compatibility and accessibility features. | EQF 5 | Skills | A comprehensive range of cognitive and practical skills to develop creative solutions |
| **Strand 2: Understanding XR Hardware and Software for Teaching** | E 2.3 | Select appropriate XR applications for different educational settings. | EQF 5 | Skills | A comprehensive range of cognitive and practical skills to develop creative solutions |
| **Strand 2: Understanding XR Hardware and Software for Teaching** | E 2.4 | Ensure ethical handling of student data and informed consent in XR environments. | EQF 5 | Responsibility and Autonomy | Exercise management and supervision in contexts of work or study activities |
| **Strand 3: Pedagogical Strategies for XR Integration** | E 3.1 | Develop teaching and learning plans incorporating XR to enhance subject learning. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |

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|---|---|---|---|---|---|
| **Strand 3: Pedagogical Strategies for XR Integration** | E 3.2 | Apply active learning principles to XR-based instruction. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 3: Pedagogical Strategies for XR Integration** | E 3.3 | Assess learning outcomes in XR-enhanced lessons. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 3: Pedagogical Strategies for XR Integration** | E 3.4 | Foster inclusive and accessible learning environments in immersive education settings. | EQF 6 | Responsibility and Autonomy | Manage complex technical or professional activities or projects |
| **Strand 4: XR Content Creation for Educators** | E 4.1 | Use XR authoring tools to create interactive learning materials. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 4: XR Content Creation for Educators** | E 4.2 | Adapt existing 3D content for use in educational settings. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |

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|---|---|---|---|---|---|
| **Strand 4: XR Content Creation for Educators** | E 4.3 | Implement assessment techniques for measuring student engagement in XR. | EQF 6 | Skills | Advanced skills, demonstrating mastery and innovation |
| **Strand 4: XR Content Creation for Educators** | E 4.4 | Address bias and ethical concerns in XR educational content development. | EQF 6 | Responsibility and Autonomy | Manage complex technical or professional activities or projects |
| **Strand 5: Evaluating and Improving XR-Enhanced Teaching** | E 5.1 | Critically assess student engagement and learning effectiveness in XR lessons. | EQF 7 | Skills | Specialised problem-solving skills in research and/or innovation |
| **Strand 5: Evaluating and Improving XR-Enhanced Teaching** | E 5.2 | Collect and analyse student feedback to improve XR teaching methodologies. | EQF 7 | Skills | Specialised problem-solving skills in research and/or innovation |
| **Strand 5: Evaluating and Improving XR-Enhanced Teaching** | E 5.3 | Reflect on ethical responsibilities in immersive teaching, including green skills. | EQF 7 | Responsibility and Autonomy | Take responsibility for contributing to professional knowledge and practice |

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|---|---|---|---|---|---|
| **Strand 5: Evaluating and Improving XR-Enhanced Teaching** | E 5.4 | Design an XR-enhanced teaching strand and present it to peers for evaluation. | EQF 7 | Skills | Specialised problem-solving skills in research and/or innovation |

## Appendix C: Adaptation of Student Curriculum Learning Outcomes Across EQF Levels 4 and 5

The adapted learning outcome table provides a set of tangible benefits to both the curriculum design process and the wider Alliance4XR project:

### Enhancing EQF-Level Clarity

The table clearly demonstrates how core learning outcomes—such as ethical awareness or XR hardware configuration—are differentiated across EQF Levels 4 to 7. By articulating changes in cognitive demand and learner autonomy, it facilitates more precise planning for teaching, learning, and assessment, while also supporting clear progression pathways.

### Reinforcing ECVET and EQAVET Alignment

By linking learning outcomes to differentiated performance expectations and corresponding assessment methods, the table supports modular curriculum design that is consistent with European standards for credit transfer and quality assurance. This scaffolding enables the development of portable qualifications and stackable micro-credentials.

### Supporting Learner-Centred Flexibility

The adaptation model illustrates how the same strand content can be delivered across multiple entry points, making it easier for VET providers, HEIs, and CPD centres to customise delivery based on learner background and target EQF level. This flexibility aligns with the inclusive, learner-responsive principles at the heart of the Alliance4XR curriculum.

### Offering a Practical Pedagogical Tool

Beyond curriculum development, the table functions as a valuable reference for educators and instructional designers. It can inform the writing, refinement, and validation of outcomes, supporting internal quality assurance and future iterations of the curriculum.

| Original Strand 1 Learning Outcomes | EQF Level 4 Adaptation | Assessment Method (L4) | EQF Level 5 Adaptation | Assessment Method (L5) |
|---|---|---|---|---|
| 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. | The original Learning Outcome is at this Level | Quiz + Visual identification task | Compare applications of XR types (VR, AR, MR, IXR) across education, industry, and entertainment sectors. | Case study comparison + short report |
| 1.2 Describe the historical development and future trends in XR technology. | The original Learning Outcome is at this Level | Poster or timeline presentation | Analyse key historical developments and predict future trends based on current XR research. | Analytical essay or group presentation |
| 1.3 Identify key hardware and software components used in XR environments. | The original Learning Outcome is at this Level | Interactive matching task + oral presentation | Explain how XR components work together in different environments (e.g. education, industry). | Annotated diagram with written explanations |
| 1.4 Recognise the ethical implications of XR, including privacy concerns, health and safety risks of XR, and social implications. | Identify common ethical concerns in XR use (e.g., eye strain, privacy). | Group discussion + reflection journal | The original Learning Outcome is at this Level | Written analysis + ethics scenario response |

| Original Strand 2 Learning Outcomes | EQF Level 4 Adaptation | Assessment Example (L4) | EQF Level 5 Adaptation | Assessment Example (L5) |
|---|---|---|---|---|
| 2.1 Demonstrate the ability to set up, configure, and troubleshoot XR hardware (headsets, AR devices, motion tracking systems, etc.). | The original Learning Outcome is at this Level | Practical setup task with checklist | Independently set up and troubleshoot XR hardware systems in a classroom or lab setting. | Scenario-based trouble shooting task |
| 2.2 Compare different XR platforms and development tools (e.g. Alliance4XR, Unity, Unreal Engine, WebXR). | Identify and describe key features of common XR platforms using visual aids. | Platform identification quiz + short summary | The original Learning Outcome is at this Level | Comparative report + presentation |
| 2.3 Apply basic programming concepts in XR environments to create interactive elements. | Use drag-and-drop or block-based tools to modify simple XR content. | Interactive workshop with visual editing | The original Learning Outcome is at this Level | Basic programming task using templates |
| 2.4 Assess the privacy risks associated with data collection in XR devices and propose leading practices for responsible use. | Recognise situations where XR devices might collect personal data. | Scenario cards + group discussion | The original Learning Outcome is at this Level | Written analysis of case study with recomm-endations |

| Original Strand 3 Learning Outcomes | EQF 4 Adaptation | Assessment Example (L4) | EQF 5 Adaptation | Assessment Example (L5) |
|---|---|---|---|---|
| **3.1** Utilise 3D modelling tools to create assets for XR applications. | Identify and use basic 3D modelling tools to create simple assets for XR applications with guidance. | EQF 4: Practical demonstration using basic tools | The original Learning Outcome is at this Level | EQF 5: Portfolio of developed 3D assets and reflective report. |
| **3.2** Develop interactive XR simulations for engineering and applied science applications. | Follow structured instructions to assist in building basic XR simulations for familiar contexts. | EQF 4: Group project with scaffolded steps | Independently develop functional XR simulations addressing well-defined engineering or science scenarios | EQF 5: Individual simulation project with documented process. |
| **3.3** Implement real-time physics and spatial interactions within XR environments. | Apply basic physics concepts under supervision to influence interactions in XR environments. | EQF 4: Annotated walkthrough and instructor-led testing | Apply standard physics rules and spatial logic to create interactive behaviours in XR environments. | EQF 5: Prototype demo and explanation video. |
| **3.4** Analyse ethical considerations in XR engineering applications, including safety, accessibility, inclusivity in virtual spaces and the impact of GenAI. | Recognise key ethical issues in XR engineering contexts and describe their impact. | EQF 4: Short-answer quiz and class discussion. | Analyse ethical implications in XR engineering, identifying risks and proposing mitigations. | EQF 5: Case study analysis and position paper. |

| Original Strand 4 Learning Outcomes | EQF Level 4 Adaptation | Assessment Example (L4) | EQF Level 5 Adaptation | Assessment Example (L5) |
|---|---|---|---|---|
| **4.1** Apply XR solutions to specific industry needs (including structural engineering, energy and grids, and the maritime sector). | Identify basic XR solutions used in different industries such as engineering or maritime. | EQF 4: Short report identifying XR applications by sector. | The original Learning Outcome is at this Level | EQF 5: Demonstration or role-play of an XR-based industry task. |
| **4.2** Design scenario-based training simulations that mirror real-world job environments. | Describe simple training scenarios that reflect common workplace situations. | EQF 4: Presentation or worksheet describing training scenarios. | Create a basic XR training scenario relevant to a specific job role. | EQF 5: Design and share a prototype XR scenario. |
| **4.3** Optimise user interaction and experience design for different audiences. | Recognise differences in how users interact with XR systems. | EQF 4: Quiz or matching task on user interaction styles. | Adapt XR content or settings to improve usability for a defined user group. | EQF 5: Usability test with user feedback analysis. |
| **4.4** Evaluate ethical challenges in industry-specific XR implementations, such as data security and digital labour rights in virtual workspaces. | Identify basic ethical concerns related to XR use in workplaces (e.g., privacy, fairness). | EQF 4: Case study analysis or ethical dilemma worksheet. | Discuss ethical risks and suggest responsible practices for XR in a chosen industry. | EQF 5: Group discussion or short essay proposing mitigation strategies. |

| Original Strand 5 Learning Outcome | EQF Level 4 Adaptation | Assessment Example L4 | EQF Level 5 Adaptation | Assessment Example L5 |
|---|---|---|---|---|
| **5.1** Create multi-user XR experiences that support real-time interaction and collaboration. | Describe basic features of multi-user XR experiences and explain how they support real-time interaction. | Level 4: Short written explanation and annotated screenshots. | Develop a simple XR environment that allows for real-time interaction between users. | Level 5: Demonstration of basic multi-user XR prototype. |
| **5.2** Use networking technologies to facilitate shared virtual spaces. | Identify key networking technologies used in shared XR environments. | Level 4: Multiple-choice quiz and short report. | Configure basic networking components to enable a shared virtual XR space. | Level 5: Practical setup demonstration and oral explanation. |
| **5.3** Develop social XR applications that encourage effective communication and engagement. | List features of social XR applications that promote user interaction. | Level 4: Illustrated concept map and oral presentation. | Design a basic social XR scenario that supports communication and collaboration. | Level 5: Scenario design with peer review and feedback log. |
| **5.4** Address cybersecurity and user safety concerns in networked XR environments. | Recognise common cybersecurity and safety issues in XR environments. | Level 4: Scenario-based quiz and class discussion. | Recommend practices to ensure user safety and data protection in XR applications. | Level 5: Case study analysis and written safety protocol. |

| Original Strand 6 Learning Outcomes | EQF Level 4 Adaptation | Assessment Example (L4) | EQF Level 5 Adaptation | Assessment Example (L5) |
|---|---|---|---|---|
| **6.1** Design and develop a fully functional XR application addressing a real-world problem. | Assist in the design of a basic XR feature or component that addresses a simple real-world problem. | Practical task: modify an existing XR application for a basic task with guided support. | Contribute to the design and development of an XR application prototype that solves a defined real-world problem. | Project-based assessment: collaborate on designing a prototype XR application with documentation of design choices |
| **6.2** Integrate ethical frameworks into the project development process, ensuring responsible innovation including green skills. | Identify basic ethical issues in XR project work, including environmental considerations. | Short reflective journal on ethical issues discussed during the project. | Apply ethical guidelines in the development of an XR application, incorporating basic green skills. | Case study analysis and ethical checklist applied to student project. |
| **6.3** Conduct user testing and feedback analysis to improve XR usability and accessibility. | Participate in user testing by gathering basic feedback with support. | Participation in guided usability test and group discussion. | Conduct user testing using predefined tools and analyse feedback to suggest usability improvements. | Practical assessment involving user testing with short written report on improvements. |
| **6.4** Present findings in a professional demonstration and written report, detailing technical execution and ethical considerations. | Contribute to a group presentation outlining the project process and basic ethical issues. | Group presentation with peer and tutor feedback. | Deliver an individual or team presentation supported by a brief written report on the XR project. | Presentation and short report assessed using a structured rubric. |

## Appendix D: Adaptation of Student Curriculum Learning Outcomes Across EQF Levels 6 and 7

| Original Strand 1 Learning Outcomes | EQF Level 6 Adaptation | Assessment Example (L6) | EQF Level 7 Adaptation | Assessment Example (L7) |
|---|---|---|---|---|
| **1.1** Define Extended Reality (XR) including but not limited to Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and Intelligent XR (IXR); distinguish their applications. | Critically explain XR classifications (VR, AR, MR, IXR), analyse their comparative affordances, and evaluate use-case applicability across sectors. | EQF 6: Comparative analysis report. | Evaluate emerging XR typologies (including IXR), critique their convergence across platforms, and propose innovative sector-specific applications. | EQF 7: Sector innovation briefing with speculative design scenario. |
| **1.2** Describe the historical development and future trends in XR technology. | Analyse the historical trajectory of XR and project implications for current technological integration. | EQF 6: Annotated timeline with commentary. | Forecast future XR developments using trend analysis and propose strategic implementation models for innovation leadership. | EQF 7: Foresight paper and roadmap. |
| **1.3** Identify key hardware and software components used in XR environments. | Compare and contrast current XR systems, identifying technical specifications relevant to sector-specific applications. | EQF 6: Technical comparison chart with justification. | Critically evaluate XR hardware/software architectures and design a specification brief tailored to a complex project. | EQF 7: Technical proposal and design brief. |
| **1.4** Recognise the ethical implications of XR, including privacy concerns, health and safety risks of XR, and social implications. | Analyse ethical concerns in XR use across domains, including health, safety, surveillance, and data protection. | EQF 6: Case-based ethical analysis. | Develop and defend a robust ethical framework to guide XR design and deployment in multi-stakeholder environments | EQF 7: Ethical white paper with applied guidelines. |

| Original Strand 2 Learning Outcomes | EQF Level 6 Adaptation | Assessment Example (L6) | EQF Level 7 Adaptation | Assessment Example (L7) |
|---|---|---|---|---|
| **2.1** Demonstrate the ability to set up, configure, and troubleshoot XR hardware (headsets, AR devices, motion tracking systems, etc.). | Independently set up, configure, and troubleshoot complex XR hardware systems across multiple environments, demonstrating effective problem-solving strategies. | EQF 6: Practical lab demonstration; Troubleshooting report | Lead the design and optimisation of XR hardware deployment strategies in diverse educational or industrial contexts, critically evaluating performance and proposing innovative solutions. | EQF 7: Deployment strategy presentation; Innovation proposal |
| **2.2** Compare different XR platforms and development tools (e.g. Alliance4XR, Unity, Unreal Engine, WebXR). | Analyse and compare the functionality and pedagogical affordances of XR platforms and tools for specific use cases. | EQF 6: Comparative analysis paper; Case study report | Evaluate and recommend XR platform strategies in relation to emerging trends, pedagogical frameworks, and organisational needs. | EQF 7: Strategic recommendation briefing; Peer-reviewed evaluation |
| **2.3** Apply basic programming concepts in XR environments to create interactive elements. | Develop interactive XR components using scripting or programming tools to meet defined learning or usability goals. | EQF 6: Code submission with explanation; Functionality demo | Design and lead the development of advanced interactive XR features, integrating user feedback and accessibility considerations. | EQF 7: Project-based XR application; Usability evaluation report |
| **2.4** Assess the privacy risks associated with data collection in XR devices and propose leading practices for responsible use. | Critically assess data protection implications of XR deployments and apply ethical frameworks to | EQF 6: Risk assessment report; Ethical reflection | Develop organisational or policy-level guidelines for responsible XR data governance in | EQF 7: Policy document draft; Stakeholder briefing |

| | | | |
|---|---|---|---|
| propose risk mitigation strategies. | journal | alignment with legal and ethical standards. | |

| Original Strand 3 Learning Outcomes | EQF Level 6 Adaptation | Assessment Example (L6) | EQF Level 7 Adaptation | Assessment Example L7) |
|---|---|---|---|---|
| **3.1** Utilise 3D modelling tools to create assets for XR applications. | Apply advanced 3D modelling techniques to design functional XR assets for complex applications. | EQF 6: Portfolio submission of complex 3D assets. | Design and evaluate innovative 3D XR assets using advanced modelling tools for interdisciplinary applications. | EQF 7: Project-based assessment with peer review and technical critique. |
| **3.2** Develop interactive XR simulations for engineering and applied science applications. | The original Learning Outcome is at this Level | EQF 6: Practical simulation project. | Lead the design and evaluation of XR simulations that solve interdisciplinary problems in engineering and science. | EQF 7: Capstone simulation project with reflective report. |
| **3.3** Implement real-time physics and spatial interactions within XR environments. | The original Learning Outcome is at this Level | EQF 6: Demonstration with scenario walkthrough. | Optimise and critically assess real-time physics engines in XR environments for complex, dynamic user interaction. | EQF 7: Functional prototype and analytical review. |
| **3.4** Analyse ethical considerations in XR engineering applications, including safety, accessibility, inclusivity in virtual spaces and the impact of GenAI. | The original Learning Outcome is at this Level | EQF 6: Ethical position paper. | Critically analyse emerging ethical challenges in XR engineering including GenAI and recommend policy-aligned responses. | EQF 7: Research brief with case analysis and ethical justification. |

| Original Strand 4 Learning Outcomes | EQF Level 6 Adaptation | Assessment Example (L6) | EQF Level 7 Adaptation | Assessment Example (L7) |
|---|---|---|---|---|
| **4.1** Apply XR solutions to specific industry needs (including structural engineering, energy and grids, and the maritime sector). | Implement XR tools to solve practical problems in one industry context, using predefined parameters and stakeholder requirements. | EQF 6: Sector-specific implementation project. | Lead the development and evaluation of XR interventions across multiple sectors, demonstrating innovation and strategic alignment with industry goals. | EQF 7: Multi-sector design dossier and strategic evaluation. |
| **4.2** Design scenario-based training simulations that mirror real-world job environments. | The original Learning Outcome is at this Level | EQF 6: Simulation prototype and user walkthrough. | Create complex, multi-layered XR training systems that replicate cross-sector workflows and assess workforce readiness. | EQF 7: Comprehensive training suite and impact report. |
| **4.3** Optimise user interaction and experience design for different audiences. | The original Learning Outcome is at this Level | EQF 6: UX design mock-up and usability testing. | Lead inclusive design strategies across XR systems, integrating user analytics, accessibility data, and advanced interaction models. | EQF 7: User-centred design case study and refinement blueprint. |
| **4.4** Evaluate ethical challenges in industry-specific XR implementations, such as data security and digital labour rights in virtual workspaces. | The original Learning Outcome is at this Level | EQF 6: Ethical impact analysis. | Conduct policy-level ethical audits of XR practices across sectors, addressing regulation, labour rights, and data sovereignty. | EQF 7: Sectoral policy audit and stakeholder briefing. |

| Original Strand 5 Learning Outcomes | EQF Level 6 Adaptation | Assessment Example (L6) | EQF Level 7 Adaptation | Assessment Example (L7) |
|---|---|---|---|---|
| **5.1** Create multi-user XR experiences that support real-time interaction and collaboration. | The original Learning Outcome is at this Level | EQF 6: Scenario-based group project. | Lead the development of advanced multi-user XR environments, integrating pedagogical models and evaluating collaborative efficacy. | EQF 7: Peer-reviewed development and evaluation report. |
| **5.2** Use networking technologies to facilitate shared virtual spaces. | The original Learning Outcome is at this Level | EQF 6: Technical demonstration. | Critically evaluate and optimise networking architectures for XR platforms used in distributed learning scenarios. | EQF 7: Comparative design analysis report. |
| **5.3** Develop social XR applications that encourage effective communication and engagement. | The original Learning Outcome is at this Level | EQF 6: Interactive prototype with user feedback. | Lead the development of inclusive social XR systems, integrating cultural, ethical and communicative frameworks. | EQF 7: Cross-cultural UX case study and implementation log. |
| **5.4** Address cybersecurity and user safety concerns in networked XR environments. | The original Learning Outcome is at this Level | EQF 6: Risk audit presentation. | Evaluate and develop institutional protocols for cybersecurity and user safeguarding in complex XR ecosystems. | EQF 7: Security policy design and strategic implementation report. |

| Original Strand 6 Learning Outcomes | EQF Level 6 Adaptation | Assessment Example (L6) | EQF Level 7 Adaptation | Assessment Example (L7) |
|---|---|---|---|---|
| **6.1** Design and develop a fully functional XR application addressing a real-world problem. | The original Learning Outcome is at this Level | EQF 6: Project implementation; Application walkthrough. | Lead the end-to-end design and development of an innovative XR solution to address complex or interdisciplinary problems. | EQF 7: Innovation showcase; Project pitch and peer critique. |
| **6.2** Integrate ethical frameworks into the project development process, ensuring responsible innovation including green skills. | Apply established ethical frameworks and green principles during project planning and development phases. | EQF 6: Ethics checklist with justification; Reflective report | The original Learning Outcome is at this Level | EQF 7: Ethical audit report; Expert review panel. |
| **6.3** Conduct user testing and feedback analysis to improve XR usability and accessibility. | Design and conduct user testing using standard evaluation tools; analyse data to recommend refinements. | EQF 6: Usability test report; Accessibility checklist. | The original Learning Outcome is at this Level | EQF 7: Iterative prototype with documented design decisions; Stakeholder feedback report. |
| **6.4** Present findings in a professional demonstration and written report, detailing technical execution and ethical considerations. | Prepare a professional-level demonstration and accompanying report communicating technical and ethical dimensions clearly. | EQF 6: Project presentation; Written report with rubric. | The original Learning Outcome is at this Level | EQF 7: Public defence; Executive summary and dissemination plan. |

## Appendix E: Resources Index

### Resources Index for Students Curriculum

| No. | Title | Associated LO | Type of file | Identifier title in the cloud folder (*internal*): |
|---|---|---|---|---|
| **1** | Augmented and Virtual Reality: an introduction | - S 1.1<br>- S 1.4 | *ppt | 1.Introduction_AR-VR |
| **2** | Augmented and Virtual Reality: an introduction | - S 1.1<br>- S 1.4 | *pdf | 1.Introduction_AR-VR |
| **3** | Introduction to XR Technologies | - S 1.2 | *pdf | 2. Introduction to XR Technologies |
| **4** | VAR (part A) Concepts, Models & Applications_ Introductive Overview | - S 1.2<br>- S 1.3<br>- S2.3 | *pdf | 3. VAR (part A) Concepts, Models & Applications_ Introductive Overview - part A |
| **5** | VAR (part B) Concepts, Models & Applications_ Introductive Overview | - S 1.2<br>- S 1.3<br>- S2.3 | *pdf | 4. VAR (part A) Concepts, Models & Applications_ Introductive Overview - part B |
| **6** | Alliance4XR Introduction to XR Technologies | - S 1.1<br>- S 1.2<br>- S 1.4 | *ppt | 5.Alliance4XR Introduction to XR Technologies |
| **7** | Protection of personal data | - S1.4<br>- S2.4 | *ppt | 1.Introduction_AR-VR |
| **8** | GDPR Regulations | - S2.4 | *pdf | 2.Regulations_GDPR (EU) |
| **9** | Demonstrate the ability to set up, configure, and troubleshoot XR hardware | - S2.1 | *ppt | 3. Module_2.1 Demonstrate the ability to set up, configure, and troubleshoot XR hardware |
| **10** | Compare different XR platforms and development tools (e.g. Alliance4XR, Unity, Unreal Engine, WebXR) | - S2.2 | *ppt | 4. Compare different XR platforms and development tools e.g. Alliance4XR, Unity, Unreal Engine, WebXR |
| **11** | Applying Basic Programming Concepts in XR | - S2.3 | *ppt | 5. Applying Basic Programming Concepts in XR |
| **12** | Assessment Quiz | - S2.3<br>- S6.3 | *doc | Assessment Quiz - Strand 2 |

| | | | | |
|---|---|---|---|---|
| **13** | XR Platform Evaluation Task - Strand 2 | - S2.3<br>- S6.3 | *doc | 7. XR Platform Evaluation Task - Strand 2 |
| **14** | Identify key ethical concerns related to safety, privacy, and user wellbeing within XR engineering contexts | - S3.4<br>- S4.4 | *ppt | 1. Analyse ethical considerations in XR engineering applications |
| **15** | Utilize 3D modelling tools to create assets for XR applications | - S3.1<br>- S5.1<br>- S5.2 | *ppt | 2.Regulations_GDPR (EU) |
| **16** | Develop interactive XR simulations for engineering and applied science applications. | - S3.2<br>- S5.1<br>- S5.2<br>- S5.3 | *ppt | 3.Develop interactive XR simulations for engineering and applied science applications |
| **17** | Implement real-time physics and spatial interactions within XR environments | - S3.3<br>- S6.1 | *ppt | 4. Spatial interactions in XR environments |
| **18** | Analyse ethical considerations in XR engineering applications | - S3.4<br>- S4.4<br>- S6.2 | *ppt | 5.Analyse ethical considerations in XR engineering applications |
| **19** | Apply XR solutions to specific industry | - S4.1 | *ppt | 1. Apply XR solutions to specific industry |
| **20** | Design scenario-based training simulations that mirror real-world job environments | - S42<br>- S5.1 | *ppt | 2.Design scenario-based training simulations that mirror real-world job environments |
| **21** | Optimise user interaction and experience design for different audiences | - S4.3<br>- S5.2<br>- S5.3 | *ppt | 3. Optimise user interaction and experience design for different audiences |
| **22** | Evaluate ethical challenges in industry-specific XR implementations | - S4.4<br>- S6.2<br>- S6.4<br>- S5.4 | *ppt | 4.Evaluate ethical challenges in industry-specific XR implementations |
| **23** | Case study videos | - S6.1 | *mp4 | - 5a.Pressure plot ZEST<br>- 5b.Side view<br>- 5c.ZEST(cleaned)-video (7) |
| **24** | Model example | - S6.1 | | - 6.ZEST(cleaned) |

| | | | | |
|---|---|---|---|---|
| **25** | Advanced XR Applications Across Industries | - S5.1<br>- S.6.1 | *ppt | - 7.Advanced XR Applications Across Industries |
| **26** | Collaborative and multiuser XR Environments | - S5.1<br>- S5.2 | *pdf | 1. Collaborative and Multi-User XR Environments |
| **27** | Create multi-user XR experiences that support real-time interaction and collaboration | - S5.1<br>- S5.2 | *ppt | 2.Create multi-user XR experiences that support real-time interaction and collaboration |
| **28** | Use networking technologies to facilitate shared virtual spaces | - S5.2 | *ppt | 3. Use networking technologies to facilitate shared virtual spaces |
| **29** | Develop social XR applications that encourage effective communication and engagement | - S5.3 | *ppt | 4.Develop social XR applications that encourage effective communication and engagement |
| **30** | Address cybersecurity and user safety concerns | - S5.4 | *ppt | 5.Address cybersecurity and user safety concerns |
| **31** | Reports | - S5.3 | *pdf | 6. Reports |
| **32** | Create multi-user XR experiences | - S5.1 | *doc | 7.Create multi-user XR experiences |
| **33** | Address cybersecurity and user safety | - S5.4 | *doc | 8.Address cybersecurity and user safety |
| **34** | Capstone Project Developing an XR Application | - S6.1 | *ppt | Capstone Project Developing an XR Application |
| **35** | Supplementary Materials | - S6.1 | *blend | 2.Supplementary Materials (3D Models, images etc) |
| **36** | Integrate ethical frameworks into the project development process | - S6.2<br>- | *ppt | 3.Integrate ethical frameworks into the project development process |
| **37** | Conduct user testing and feedback analysis | - S6.3 | *ppt | 4. Conduct user testing and feedback analysis |
| **38** | Present findings in a professional | - S6.4 | *doc | 5.Present findings in a professional |

| | | | | |
|---|---|---|---|---|
| | demonstration and written report | | | demonstration and written report |
| **39** | Design and develop a fully functional XR application addressing a real-world problem | - S6.1 | *ppt | 6. Design and develop a fully functional XR application addressing a real-world problem |

## Resources Index for Educators Curriculum

| No. | Title | Associated LO | Type of file | Identifier title in the cloud folder *(internal)*: |
|---|---|---|---|---|
| **1** | Introduction to XR technologies | - E1.1 | *pdf | 1.Introduction to XR technologies |
| **2** | Introduction to XR Technologies- Basic Definitions | - E1.1 | *ppt | 2.Introduction to XR Technologies- Basic Definitions |
| **3** | Evaluate platform compatibility and accessibility features. | - E1.2<br>- E2.1<br>- E2.2 | *ppt | 1. Evaluate platform compatibility and accessibility features. |
| **4** | Selecting Appropriate XR Applications for Educational Settings | - E1.1<br>- E1.2<br>- E2.1<br>- E2.3 | *ppt | 2. Selecting Appropriate XR Applications for Educational Settings |
| **5** | Demonstrate setup and troubleshooting of XR classroom tools | - E2.1<br>- E2.2<br>- E2.3 | *ppt | 3. Demonstrate setup and troubleshooting of XR classroom tools |
| **6** | Ensure ethical handling of student data and informed consent in XR learning environments | - E1.3<br>- E1.4<br>- E2.4 | *ppt | 4. Ensure ethical handling of student data and informed consent in XR learning environments |
| **7** | Pedagogical Strategies for XR Integration | - E3.1<br>- E3.2 | *doc | 1. Pedagogical Strategies for XR Integration. |
| **8** | Develop teaching and learning plans incorporating XR to enhance subject learning | - E3.1 | *ppt | 2. Develop teaching and learning plans incorporating XR to enhance subject learning |
| **9** | Apply active learning principles to XR-based instruction | - E3.2 | *ppt | 3. Apply active learning principles to XR-based instruction |
| **10** | Assess learning outcomes in XR-enhanced lessons | - E3.3 | *ppt | 4. Assess learning outcomes in XR-enhanced lessons |

| | | | | |
|---|---|---|---|---|
| **11** | Foster inclusive and accessible learning environments in immersive education settings | - E3.4 | *ppt | 5.Foster inclusive and accessible learning environments in immersive education settings |
| **12** | Use XR authoring tools to create interactive learning materials | - E4.1 | *ppt | 1.Use XR authoring tools to create interactive learning materials |
| **13** | Adapt existing 3D content for use in educational settings | - E4.2 | *ppt | 2. Adapt existing 3D content for use in educational settings |
| **14** | Implement assessment techniques for measuring student engagement in and learning through XR | - E4.3<br>- E5.1<br>- E5.2 | *ppt | 3.Implement assessment techniques for measuring student engagement in and learning through XR |
| **15** | Address bias and ethical concerns in XR educational content development. | - E4.4<br>- E5.3 | *ppt | 4. Address bias and ethical concerns in XR educational content development. |
| **16** | ALLIANCE4XR platform presentation | - E4.2<br>- E5.4 | *mp4 | 5.Alliance4XR presentation |
| **17** | Use XR authoring tools to create interactive learning materials. | - E4.1 | *ppt | 6.Use XR authoring tools to create interactive learning materials. |
| **18** | Evaluating and Improving XR-Enhanced Teaching | - E5.1<br>- E5.4 | *doc | 1. Evaluating and Improving XR-Enhanced Teaching |

## Appendix F: Alliance4XR Learning Pathway Planner for VET Providers

This Learning Pathway Planner supports VET providers in designing modular XR curricula aligned with the EQF framework. Use this template to identify appropriate strands, EQF levels, learning outcomes, and assessment approaches.

### 1. Course Information

| | |
|---|---|
| Course Title: | |
| EQF Level: | |
| Target Learners / Sector: | |
| Delivery Format (e.g., in-person, blended, online): | |

### 2. Selected Curriculum Strands

List the relevant curriculum strands and associated learning outcomes:

| Strand | Selected Learning Outcomes | Justification for Inclusion (skills relevance, industry demand, etc.) |
|---|---|---|
| | | |

### 3. Assessment Strategy

Specify formative and summative assessment methods aligned to EQF domains (Knowledge, Skills, Responsibility & Autonomy):

| Learning Outcome | Assessment Type (Formative/Summative) | Assessment Method (e.g., project, quiz, demonstration) | Mapped EQF Domain |
|---|---|---|---|
| | | | |

### 4. Micro-Credential Opportunities

Outline how partial completion or focused strands could support micro-credentialing:

| |
|---|
| |

**5. Accessibility and Inclusion Measures**

Describe how UDL and accessibility principles will be implemented to support learner variability:

| |
|---|
| |

## Appendix G: Alliance4XR Learning Pathway Planner for HEI Providers

This Learning Pathway Planner supports Higher Education Institutions (HEIs) in developing flexible, modular XR curricula aligned with the EQF framework. It enables integration of the Alliance4XR strands into undergraduate and postgraduate programmes across disciplines.

### 1. Programme Information

| | |
|---|---|
| Programme Title: | |
| EQF Level: | |
| Disciplinary Area(s): | |
| Mode of Delivery (e.g., on-campus, blended, online): | |

### 2. Integrated Curriculum Strands

Select relevant curriculum strands and specify how they will be embedded in course modules:

| Strand | Learning Outcomes and Module Alignment | Rationale for Selection (disciplinary relevance, research alignment, innovation focus) |
|---|---|---|
| | | |

### 3. Assessment and Credit Strategy

Define assessment strategies across the integrated modules, aligned with EQF domains and academic standards:

| Learning Outcome | Assessment Type (Formative/Summative) | Assessment Method (e.g., presentation, simulation, research project) | Mapped EQF Domain |
|---|---|---|---|
| | | | |

### 4. Capstone or Thesis Integration (if applicable)

Describe how XR-related learning will be synthesised in a final project, thesis, or portfolio.

**5. Interdisciplinary Opportunities**

Note where XR modules intersect with other faculties, research centres, or industry partnerships:

## Appendix H: Example Alliance4XR HEI Micro-Credential Planner

### Strand 1 Student Alliance 4XR Curriculum - Introduction to XR Technologies

This micro-credential is designed for Higher Education learners to build foundational awareness of XR (Extended Reality) technologies, including VR, AR, MR, and Intelligent XR (IXR). Learners engage in conceptual, technical, and ethical explorations of XR, preparing them for applied modules in later strands or sector-specific deployment. Total estimated learning time: 25-30 hours (contact + independent study).

### Learning-Activity Matrix

| Learning Outcome | Suggested Learning Activities | Mode & Resources | Alignment Rationale |
|---|---|---|---|
| **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.** | • Timeline on Miro board of XR milestones.<br>• Case study breakout groups exploring sector-specific XR applications.<br>• Create a visual concept map distinguishing XR types. | Synchronous online or in-person workshop with breakout groups and a digital whiteboard (e.g., Miro). | Helps students differentiate XR modalities and contexts of use. |
| **1.2 Describe the historical development and future trends in XR technology.** | • Collaborative 'XR through the decades' digital wall.<br>• Presentations on recent XR trend articles and market forecasts. | Asynchronous research task + short synchronous lightning talks. | Builds shared timeline and awareness of the rapid pace of change in the XR field. |
| **1.3 Identify key hardware and software components used in XR environments.** | • Interactive lab or virtual tool demonstration.<br>• Group worksheet: match components to use-cases (e.g., haptics in health XR). | Blended: Video demos and (where possible) hands-on or emulator-based trials. | Grounds theory in the tangible interfaces learners will encounter. |

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| **1.4 Recognise the ethical implications of XR, including privacy concerns, health and safety risks of XR, and social implications.** | • Annotated screenshots of XR interfaces highlighting potential ethical issues.<br>• Learner-created short podcast or storyboard: 'XR gone wrong – and how to fix it.' | Multimodal: students choose visual, audio, or text format; guided template support. | Encourages reflection and anticipatory ethical thinking before deployment. |

**Sequencing & Assessment Notes**

- Begin with conceptual clarity (1.1) to establish terminology. Historical and technical context (1.2, 1.3) provide scaffolding.
- Conclude with 1.4 to promote ethical reflection after students have seen examples in use.
- Assessment is portfolio-based: learners submit a reflective concept map (LO 1.1), a presentation (LO 1.2), a matching worksheet (LO 1.3), and a multimodal ethics task (LO 1.4).

**Strand 2 Student Alliance 4XR Curriculum – XR Hardware & Software Setup**

This micro-credential is designed for Higher Education learners seeking foundational competence in setting up, evaluating, and ethically deploying XR hardware and software systems. It equips students with hands-on experience in configuring devices, troubleshooting common issues, comparing development platforms, and understanding the implications of data collection and system design. This strand is particularly relevant for learners progressing toward development and implementation roles in XR-enhanced industries or applied research contexts. The learning design combines experiential labs, technical comparisons, programming micro-labs, and ethical case studies to develop both operational fluency and reflective practice.

Total estimated learning time: 25-30 hours (contact + independent study).

| Learning outcome | Suggested learning activities | Mode & resources | Alignment rationale |
|---|---|---|---|
| **2.1 Demonstrate the ability to set up, configure, and troubleshoot XR hardware (headsets, AR devices, motion tracking systems, etc.).** | 1. **"Unbox-and-Build" lab** – small teams follow a checklist to assemble a headset/AR glasses bundle; log every step in a shared troubleshooting diary. 2. **Fault-injection race** – instructor secretly mis-configures devices (wrong IP, occluded sensor, outdated firmware). Teams diagnose & fix as fast as possible, then record a 60-sec video walkthrough of the solution. | In-person or remote via shipping kits + live camera feed; printed "quick-start" cards; shared Padlet diary. | Students physically manipulate devices, practise systematic fault isolation, and create a reusable peer knowledge base. |
| **2.2 Compare different XR platforms and development tools (e.g. Alliance4XR, Unity, Unreal Engine, WebXR).** | 1. **Platform carousel** – each team is assigned *one*stack (Alliance4XR, Unity, Unreal, WebXR). They build a 5-min "Hello World" scene, record | Hybrid; lab PCs or cloud-VMs; metrics template; Miro. | Makes students experience each tool's workflow first-hand and |

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|---|---|---|---|
| **Compare XR platforms & dev tools** | CPU/GPU/RAM & build time, and post findings. 2. **Jigsaw teach-back** – regroup so every new team has an expert for each platform; they co-create a comparison matrix (features, licensing, typical use-cases) in Miro and vote on suitability for three given scenarios (e.g. museum guide, industrial simulation, public-web AR). | | articulate pros/cons rather than memorisin g specs. |
| **2.3 Apply basic programming concepts in XR environments to create interactive elements.** | 1. **Code-along micro-labs** – instructor live-codes 3 snippets (spawn object, grab/drag, simple UI) in chosen engine; students replicate and tweak one parameter. 2. **Interactive-element sprint** – 90-min hack where pairs extend the micro-lab into a tiny scene (e.g., "ring-toss" or "museum label"). They submit a 1-min screen-capture demo & Git repo. Peer review via rubric focusing on clarity, naming, and commenting. | Synchronous live-coding (Zoom + IDE screen-share); template projects; Git classroom. | Moves from guided practice to creative application; peer review strengthen s code literacy and feedback culture. |
| **2.4 Assess the privacy risks associated with data collection in XR devices and propose leading practices for responsible use.** | 1. **Data-trace scavenger hunt** – students use an open-source packet sniffer or platform logs while an XR app runs; list every data point captured (location, gaze, | Remote-friendly; Wireshark/Oculu s/SteamVR logs; Miro / paper; video upload. | Makes the invisible visible (actual data flow), then pushes learners to transfer |

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| | biometrics).<br>2. **Risk storyboard** – groups pick one data point and create a four-panel comic (physical or digital whiteboard) illustrating a misuse scenario + a mitigation (e.g., edge processing, opt-in UI, anonymisation).<br>3. **Lightning policy pitch** – 2-min recorded elevator pitch advocating a "responsible-use checklist" for their institution. | | insight into concrete safeguards and persuasive communication. |

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**Sequencing & scaffolding**

1. **Hardware first** (LO 1) – essential for anyone who will later develop or test.
2. **Platform discovery** (LO 2) – builds on working devices and primes tool choice.
3. **Coding basics** (LO 3) – now that students know where things run, they make something run.
4. **Privacy & ethics** (LO 4) – woven throughout but culminates after students have generated real data traces with their prototypes.

**UDL & accessibility tweaks**

- Provide captioned recordings of all demos and a step-by-step photo walkthrough.
- Offer a "simulation-only" path (WebXR emulator, recorded sensor feeds) for learners without local hardware.
- Let students choose the medium of deliverables (video, annotated slides, or podcast) to accommodate varied strengths.

**Assessment hooks**

- The troubleshooting diary and comparison matrix feed directly into the **formative reflections** you designed earlier.
- The mini-scene and policy pitch can be reused—as-is or iterated—for the **summative portfolio** at the end of Strand 2.

## Appendix I: Example Alliance4XR Assessment Rubrics

**Capstone Project Assessment Rubric (EQF Level 5)**

| Criteria | Excellent (90–100%) | Good (75–89%) | Satisfactory (60–74%) | Needs Improvement (<60%) |
|---|---|---|---|---|
| **Technical Execution of XR Tools (25%)** | Consistently operates XR tools independently and accurately; few or no errors. | Operates XR tools correctly with minor support; occasional errors. | Demonstrates basic operation; frequent errors requiring support. | Struggles to operate tools; high level of guidance needed. |
| **Problem-Solving and Application (20%)** | Applies XR to defined problems effectively; solutions are logical and well executed. | Applies XR to familiar problems with success; minor weaknesses in design. | Attempts XR-based solutions; outcomes may be incomplete or lack clarity. | Struggles to link XR tools to problem; minimal practical impact. |
| **Project Planning and Organisation (15%)** | Demonstrates clear planning; milestones achieved on time; work is well structured. | Good planning evident; some deviations; work mostly well organised. | Planning inconsistent; project meets basic requirements with delays. | Limited planning evident; significant time or task management issues. |
| **Communication of Process and Outcome (15%)** | Presents project clearly using visual, written, or verbal means; logical sequencing. | Presentation is understandable with minor clarity or structure issues. | Presentation is basic; structure or clarity issues reduce effectiveness. | Presentation unclear or incomplete; key information missing. |
| **Teamwork and Interaction (15%)** | Works constructively in a team; shows responsibility and awareness of others' roles. | Participates well; generally responsible and cooperative. | Participates, but requires prompting; inconsistent collaboration. | Poor teamwork; disengaged or disruptive in group settings. |
| **Reflection and Self-Assessment (10%)** | Reflects critically on own learning; identifies strengths and areas for improvement. | Offers honest, basic reflection; identifies some learning progress. | Reflection present but superficial; unclear on future improvement. | Little or no reflection; minimal awareness of learning process. |

**Capstone Project Assessment Rubric (EQF Level 6)**

| Criteria | Excellent (90-100%) | Good (75-89%) | Satisfactory (60-74%) | Needs Improvement (below 60%) |
|---|---|---|---|---|
| **XR Technical Competence (20%)** | Demonstrates fluent, independent application of XR technologies with minimal supervision. | Demonstrates clear competence in XR technology use, needing occasional guidance. | Demonstrates basic competence; requires regular guidance. | Limited competence; requires extensive guidance. |
| **Problem Solving and Application (20%)** | Clearly identifies problems, creatively applies XR solutions. | Clearly identifies problems; effective application of XR solutions. | Identifies problems; basic XR solutions applied. | Problem identification weak; solutions superficial or incomplete. |
| **Ethical Awareness (15%)** | Thoroughly evaluates ethical implications; solutions reflect strong ethical grounding. | Considers ethical implications clearly; solutions show ethical consideration. | Acknowledges ethical dimensions; some consideration shown in solution. | Ethical awareness limited or overlooked in solutions. |
| **Collaboration and Communication (15%)** | Strong teamwork; clear, confident, effective communication. | Effective teamwork; communication clear with minor issues. | Adequate teamwork; communication sometimes unclear or hesitant. | Poor teamwork; unclear or ineffective communication. |
| **Project Management and Autonomy (15%)** | Demonstrates consistent autonomous planning; project completed efficiently and on time. | Good autonomy; occasional support required; minor timeline deviations. | Regular supervision required; project delivered, with timeline issues. | Minimal autonomy; significant delays or incomplete elements. |
| **Presentation and Reflection (15%)** | Clear, structured presentation with reflective depth and clarity. | Good presentation; reflection meaningful but could be deeper. | Basic presentation; reflection present but superficial. | Presentation unclear; minimal or no reflection. |

**Capstone Project Assessment Rubric (EQF Level 7)**

| Criteria | Excellent (90-100%) | Good (75-89%) | Satisfactory (60-74%) | Needs Improvement (below 60%) |
|---|---|---|---|---|
| **Advanced XR Technical Mastery (20%)** | Expertly demonstrates sophisticated XR design and implementation with full autonomy. | Strongly demonstrates advanced XR design and implementation with minimal support. | Demonstrates advanced XR competency with some supervisory support. | Limited mastery; frequent need for guidance; fundamental gaps evident. |
| **Innovation and Critical Thinking (20%)** | Innovatively identifies complex problems; proposes critically evaluated, original XR solutions. | Identifies complex problems; critical evaluation and innovative XR solutions clear. | Identifies problems; adequate critical evaluation; XR solutions are competent but not innovative. | Problem identification simplistic; solutions lack innovation or critical evaluation. |
| **Ethical and Societal Impact Analysis (15%)** | Provides comprehensive ethical and societal impact analysis; fully integrates ethical considerations into XR solutions. | Clear ethical and societal impact analysis; integrates ethical considerations effectively. | Some ethical and societal considerations acknowledged; integration into solutions basic. | Limited or superficial ethical and societal impact consideration. |
| **Leadership and Strategic Communication (15%)** | Demonstrates clear leadership; communication strategically persuasive and professionally sophisticated. | Effective leadership skills; clear and professionally effective communication. | Shows basic leadership; communication clear but lacking strategic depth. | Leadership skills minimal or unclear; communication ineffective or inconsistent. |
| **Research Integration and Methodology (15%)** | Exemplary integration of research literature and methodologies; demonstrates strong methodological rigour. | Good integration of research literature; methodologies well chosen and applied effectively. | Adequate use of research literature; methodologies sound but lack full justification. | Limited integration of literature; methodologies unclear or poorly justified. |
| **Reflective and Critical Evaluation (15%)** | Demonstrates outstanding reflective and critical self-evaluation; insightful, clearly presented. | Good reflective and critical evaluation; demonstrates thoughtful insights. | Basic reflective evaluation; adequate insight shown. | Limited reflective capability; minimal critical evaluation demonstrated. |