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AR/VR Tools for Learning

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AR/VR Tools for Learning
What Are AR and VR?

- Virtual Reality (VR): a fully simulated 3D environment where learners interact with tools, objects and procedures.
- Augmented Reality (AR): digital guidance layered onto the real world, supporting tasks without replacing the physical environment.
- Core distinction: VR trains inside a simulation; AR supports real work with contextual digital information.





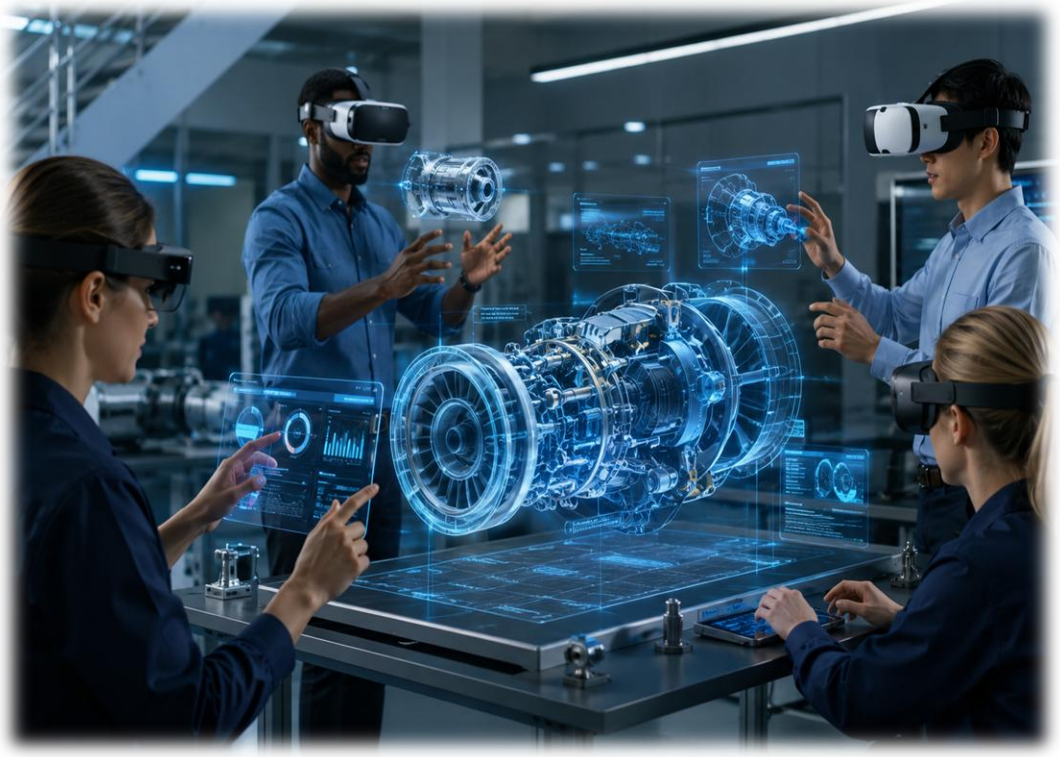
AR/VR Tools for Learning
Why AR/VR Matters in Learning



- Moves training from passive explanation to active performance.
- Supports technical, procedural and decision-making skills.
- Allows safe repetition of complex, costly or hazardous tasks.
- Creates a stronger link between theory, practice and assessment.

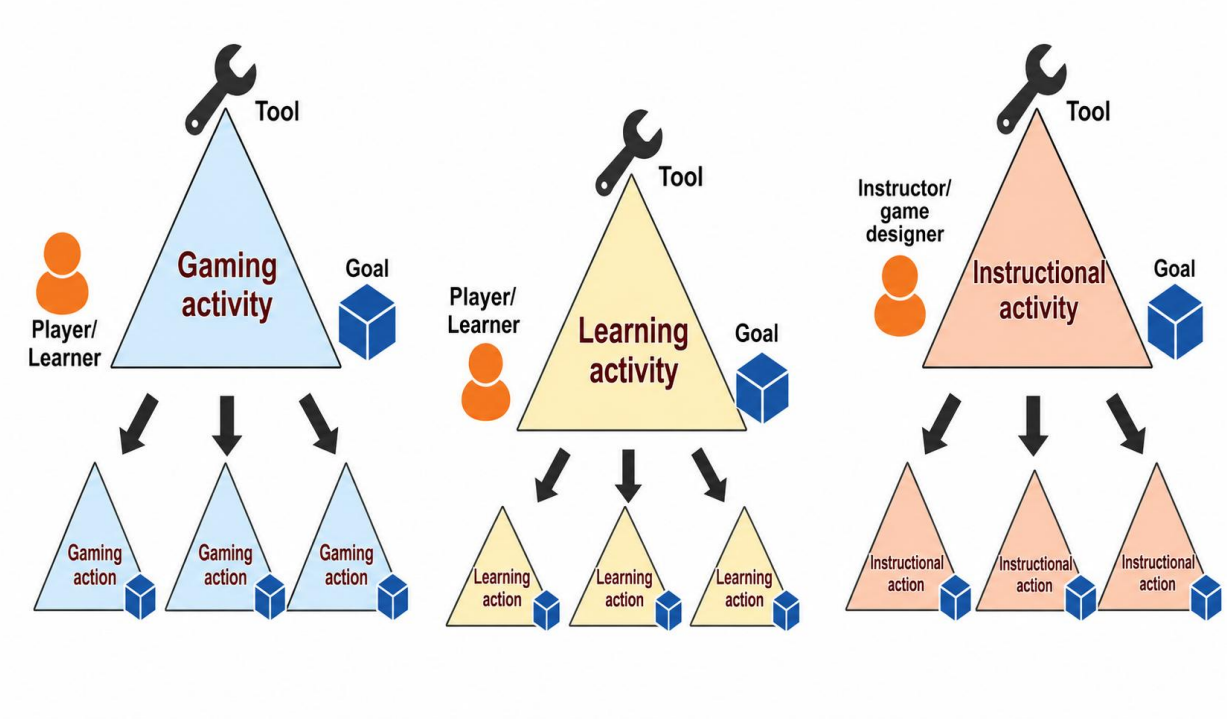
AR/VR Tools for Learning
Educational Value: Experiential Learning

- Practical Experience: AR/VR enables learners to perform realistic tasks in immersive training environments.
- Reflective Observation: Learners review their performance through system feedback and trainer evaluation.
- Conceptual Understanding: Virtual practice is linked to theoretical knowledge, procedures, and professional standards.
- Active Experimentation: Learners repeat and refine tasks in AR/VR to improve accuracy, efficiency, and competence.



AR/VR Tools for Learning
Core AR/VR Learning Practices

- Scenario-based learning anchored in authentic professional workflows.
- Guided simulations with clear objectives, prompts and feedback.
- Virtual laboratories for safe practice before real-world application.
- Serious-game logic: challenge, interaction, scoring and progression.



AR/VR Tools for Learning
Where AR/VR Is Applied

- Technical and vocational education: inspection, maintenance, assembly, troubleshooting.
- Science, Technology, Engineering, Mathematics and laboratory education: experiments, simulations and virtual labs.
- Safety-critical sectors: construction, aviation, industrial inspection and healthcare.
- Collaborative learning: remote training, demonstrations and transnational workshops.



AR/VR Tools for Learning
Virtual Laboratories for Technical Training



- Virtual labs reduce dependency on rare physical equipment.
- Learners can practice before entering real laboratories.
- Procedural mistakes become real time feedback moments rather than safety incidents.
- Repeatable scenarios help standardize training quality across locations.





AR/VR Tools for Learning
VR-VET Case Study: NDT Training

- ✓ The VR-VET project uses immersive VR for Non-Destructive Testing training.
- ✓ The practical case focuses on Liquid Penetrant Testing.
- ✓ The platform targets NDT operators, VET learners, trainers and industry professionals.
- ✓ Goal: realistic, standards-oriented practice before real industrial inspection.





AR/VR Tools for Learning
Penetrant Testing Workflow in VR

- The trainee follows a step-by-step inspection sequence.
- Typical stages include cleaning, penetrant application, removal of excess, developer application, inspection, evaluation and reporting.
- Each stage can include interactive tools, visible defects, decision points and immediate feedback.



AR/VR Tools for Learning
Skills Developed Through VR & AR

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AR/VR-based NDT training develops practical skills such as tool handling, inspection steps, defect identification, decision-making, and safe working practices.

The system requires a compatible headset, controllers, tracking, sufficient computer resources, and reliable Internet access for realistic liquid penetrant testing training.



AR/VR Tools for Learning
Technology Stack Behind Immersive Learning

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VR Training Platform Architecture

1 Hardware Infrastructure


VR headset


Controllers


Tracking


Computer


Network access

Provides the physical devices and connectivity that power the VR experience.

2 Software Environment

Simulation and interaction engine


Unity 3D



OpenXR


XR Interaction Toolkit

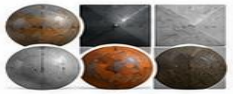

C# components

Runs the VR application, handles interactions, physics, and device abstraction.

3 Digital Content and Assets

Creates immersive and realistic learning experiences


Blender / 3D models


Realistic textures


Tool animations


Spatial audio

Provides 3D models, media, animations, and audio to build realistic simulations.

4 Learning and Analytics Layer

Educational integration, tracking, assessment, and analytics


Moodle
Course delivery



xAPI
Experience tracking


LRS
Learning Record Store

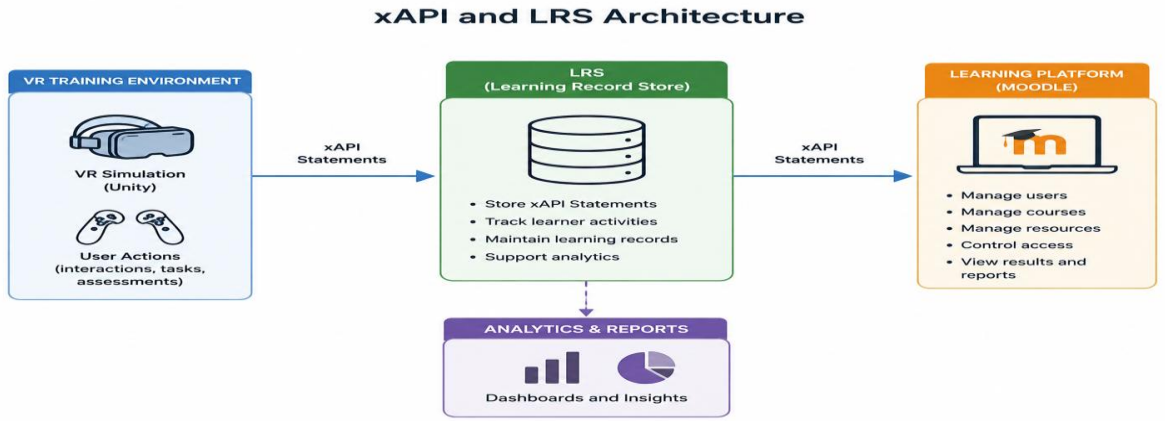

Dashboards
Analytics & reporting

Captures learner data, manages records, assesses performance, and provides insights.

AR/VR Tools for Learning
Platform Architecture: VR + LMS + Data

- The platform architecture is structured around a clear separation of functional components to ensure scalability, interoperability, and effective learning management.
- Unity provides the immersive 3D simulation environment in which trainees perform practical activities, while Moodle manages users, courses, learning resources, and access rights.
- xAPI and LRS capture VR training data, enabling structured performance tracking and analysis of the learner.





AR/VR Tools for Learning
Learning Analytics and Assessment

- ✓ VR can record task completion, timing, accuracy and user decisions.
- ✓ Performance data can be transferred to Moodle for evaluation.
- ✓ Examples: defect identification accuracy, sequence adherence and PPE confirmation.
- ✓ Analytics help trainers identify gaps and improve scenarios.



AR/VR Tools for Learning
Living Labs and Transnational Learning

The Living Lab network provides a structured framework that connects centralized VR scenario development with distributed local testing and training environments. Within this architecture, BIBA functions as the central hub, coordinating scenario development, technical validation, and system-level consistency across the VR-VET ecosystem.

Partner Living Labs contribute through local testing, validation, training delivery, and structured feedback collection. This distributed approach establishes a continuous co-creation cycle in which empirical feedback from participating institutions supports quality assurance, iterative refinement, and the ongoing improvement of both the VR scenarios and the broader training platform.



AR/VR Tools for Learning Innovation: What Makes AR/VR Different?

- Immersion: learners are placed inside the training situation.
- Interaction: learners manipulate objects, not just observe slides or videos.
- Measurement: actions become data for assessment and feedback.
- Scalability: the same validated scenario can be deployed across institutions.



AR/VR Tools for Learning
Emerging Directions in AR/VR Learning

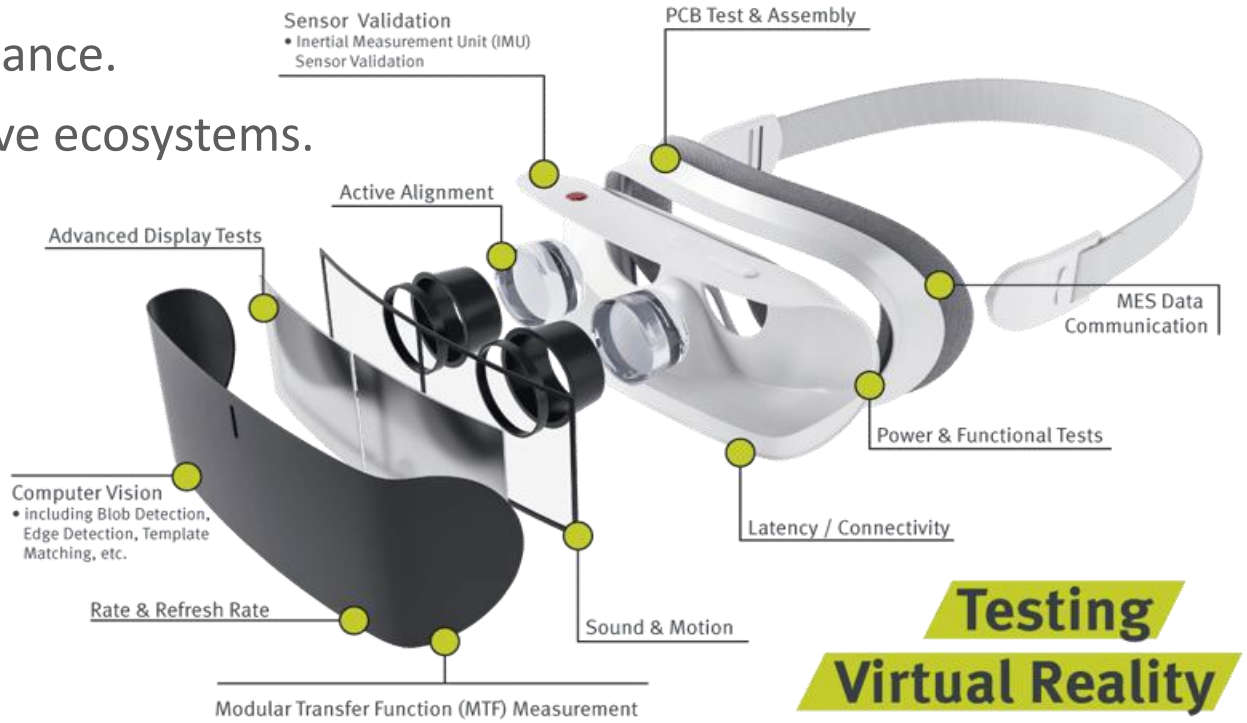
Standalone headsets and OpenXR improve portability and deployment.

Hand tracking, haptics and spatial audio increase realism.

AI-supported and adaptive learning can personalize guidance.

Education 5.0 connects VR, AR, analytics and collaborative ecosystems.





AR/VR Tools for Learning
Accessibility and Responsible Implementation

- Interface Design: AR/VR interfaces should be intuitive, visually clear, and easy to navigate, with readable content and consistent controls.
- Accessibility: Alternative interaction methods and adaptable interface options should support users with different physical abilities and levels of technical experience.
- Data Protection: Immersive learning environments must ensure informed consent, secure authentication, appropriate access control, and GDPR-compliant data management.
- Inclusive Learning: AR/VR technologies should broaden access to practical learning while minimizing technological, physical, and digital barriers.





AR/VR Tools for Learning
Challenges and Success Factors

- Challenges: development cost, content production, device compatibility and maintenance.
- Pedagogical risk: impressive visuals without clear learning outcomes.
- Success factors: objectives, standards alignment, feedback, analytics and trainer support.
- Best result: blended learning that combines classroom, e-learning, VR and real laboratory practice.









Thank you!

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