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“Fostering Socially Distanced and Inclusive on Campus Education in Armenian HEIs” - eCAMPUS

POLICY PAPER ON STANDARDS FOR E-LEARNING PLATFORMS

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CONTENTS

1. Executive Summary and Architectural Vision	3
2. Integrated Conceptual Dimensions (The 4+1 Model)	3
3. Comprehensive Benchmarking Matrix (Maturity Model)	6
4. Key Performance Indicators (KPIs) for System Validation	7
5. Implementation Roadmap for Higher Education Institutions	8
6. Quality Assurance, Continuous Improvement and Sustainability	9

1. Executive Summary and Architectural Vision

This framework establishes a comprehensive set of benchmark standards and an institutional blueprint for the next generation of LMS and e-learning platforms within Armenian HEIs. As digital education becomes central to contemporary pedagogy, these benchmarks ensure that e-learning ecosystems provide high-quality, accessible, secure, and pedagogically robust learning experiences. The framework serves as a strategic instrument for institutional self-assessment and ongoing quality enhancement.

The framework delineates quality, pedagogical, and technological criteria for HEI platforms by standardising institutional software capabilities. These requirements are mapped directly onto DigiComArm, which synthesizes European standards (DigCompEdu and DigComp 3.0) with local academic needs. The framework supports the objectives of the European Digital Education Action Plan (2021–2027) by promoting inclusive, accessible, secure, and human-centred digital learning environments in HEIs. This integration operationalises, supports, and advances the digital and artificial intelligence (AI) competencies of educators and learners by embedding AI literacy, digital sovereignty, and inclusive design into actionable software requirements, interoperability metrics, and compliance guidelines.

By moving beyond legacy, passive document-storage architectures, this framework redefines e-learning platforms as adaptive, AI-enhanced, and socially inclusive learning ecosystems intended to facilitate national educational transformation.

2. Integrated Conceptual Dimensions (The 4+1 Model)

The platform benchmarks are organized into five dimensions. Each platform requirement is aligned with the relevant instructor competence area, which ensures that the technology effectively supports both pedagogical and administrative workflows and contributes to a robust e-learning ecosystem.

DOMAIN 1: PEDAGOGICAL INTELLIGENCE, COMMUNICATION AND LEARNING ORCHESTRATION

Aligned with DigiComArm Area 1 (Professional Engagement) & Area 3 (Teaching & Learning)

- **1.1 Fluid Synchronous/Asynchronous Infrastructure:** The platform must natively support integrated, low-latency video conferencing engines (e.g., BigBlueButton, Zoom, or MS Teams LTI) equipped with real-time, AI-driven transcription and captioning engines. Directly bridges with the AI-Driven Audio-Visual Capture System specified in Smart Classroom Provision 2.

- **1.2 LLM Messaging & Chat Meshes (DigiComArm 1.1):** Asynchronous community hubs must feature open-standard API integrations restricted to authorized, self-hosted on-premise LLM microservices (or zero-data-retention enterprise API endpoints), guaranteeing that no localized prompt contexts are utilized for external model training, in strict alignment with Section 4.3 sovereignty rules.
- **1.3 Adaptive Pathway Architecture (DigiComArm 3.4):** The platform core must support branching conditional logic. It must automatically adjust resource recommendations and self-paced study milestones based on the student's navigation tracking, historical performance loops, and pacing selections.
- **1.4 Smart Classroom Hardware Telemetry LTI:** The platform architecture must include standardized edge-API gateways capable of ingestive telemetry exchange with physically integrated smart classroom environments (smartboards, localized audio arrays), bridging synchronous physical interaction data with the core digital LMS dashboard.

DOMAIN 2: OPEN EDUCATIONAL RESOURCES, KNOWLEDGE CO-CREATION AND DIGITAL CONTENT INNOVATION

Aligned with DigiComArm Area 2 (Digital Resources and Content Creation)

- **2.1 Native OER Curation & Metadata Engine (DigiComArm 2.1 & 2.3):** The platform repository architecture must enforce standard Creative Commons (CC) metadata schemas during the file upload process. Faculty must be able to index, tag, and publish Open Educational Resources (OER) into institutional shared knowledge bases with multi-parameter semantic search capabilities.
- **2.2 Built-In Generative Co-Creation Suites (DigiComArm 2.2):** WYSIWYG and HTML course editors must embed native interactive authoring utilities, such as H5P, seamlessly coupled with safe, network-contained generative tools (text-to-speech, layout optimization, text refinement) to enable rapid content modification.
- **2.3 Academic Integrity & Source Provenance Guardrails (DigiComArm 2.4):** The submission pipeline must integrate algorithmic verification engines (e.g., Zotero API, plagiarism detection protocols) that flag hallucinated citations and execute **cross-reference validation protocols** to guide students in responsible digital research habits.
- **2.4 Spatial and Immersive Asset Repository:** The content engine must natively ingest, preview, and catalog WebXR-compliant 3D models and AR/VR instructional scenes, embedding standard metadata schemas for spatial components.

DOMAIN 3: TRANSPARENT ASSESSMENT & PREDICTIVE DATA ANALYTICS

Aligned with DigiComArm Area 4 (Assessment and Feedback)

- **3.1 Multi-Mode Assessment Arrays (DigiComArm 4.1):** Quiz engines must handle complex formative and summative configurations, including simulation-based testing, peer-review routing matrices, rubrics mapping, and automated question-pool generation leveraging secure, localized AI assistance.
- **3.2 Privacy-Preserving Predictive Analytics (DigiComArm 4.2):** The system must generate continuous telemetry logs (login velocities, resource access rates, forum post counts) translated into visual dashboards. It must use localized data patterns to flag at-risk retention profiles for early educational intervention.
- **3.3 Multimedia Feedback Architecture (DigiComArm 4.2):** Gradebooks must support native audio/video feedback captures (e.g., inline microphone/webcam recording) alongside structural prompt blocks to facilitate detailed, personalised student-teacher dialogic evaluation.

DOMAIN 4: SOVEREIGN ACCESSIBILITY & UNIVERSAL DESIGN (UDL)

Aligned with DigiComArm Area 5 (Empowering and Engaging Learners)

- **4.1 Enforced Web Accessibility (DigiComArm 5.1):** System layouts must guarantee 100% compliance with **WCAG 2.2 AA standards**. This includes native semantic structures for screen readers, high-contrast dynamic themes, alternative text fields for all graphic media, and adjustable text scaling engines.
- **4.2 Mobile-First/Offline Resilience Framework:** To bridge socio-economic infrastructure variations in remote regions of Armenia, the platform client must optimize rendering structures for mobile displays and support **graceful degradation** of heavy content. In low-bandwidth environments, the system must automatically substitute interactive XR/3D assets with optimized 2D modalities while providing offline package synchronization mechanisms to allow continuous learning.
- **4.3 Algorithmic Non-Bias & Data Sovereignty Infrastructure:** The platform must mandate strict encryption controls (AES-256 at rest and TLS 1.3 in transit). To enforce absolute institutional data sovereignty, all application state and telemetry must reside exclusively on-premises or within an encrypted national private cloud matrix, effectively blocking exposure of external upstream data pipelines.

DOMAIN 5: HUMAN-IN-THE-LOOP (HITL) PLATFORM GOVERNANCE

Transversal Quality Assurance and Ethical Oversight System Requirement

- **5.1 Mandatory Human Verification Gates:** The platform code must explicitly prohibit automated systems from deploying final summative scores, executing critical grading tasks, or changing student status without an asynchronous manual override/approval gate controlled by a human instructor.
- **5.2 Auditable AI Explanations:** Every automated suggestion or analytics indicator must present clear, human-readable explanatory notes showing the data points, logic parameters, and source criteria used to build the automated layout or prediction.

3. Comprehensive Benchmarking Matrix (Maturity Model)

This benchmarking matrix acts as the institutional scoring rubric, aligned with the cognitive stages of Bloom's Taxonomy.

Platform Dimension	Tier 1: Baseline (Beginner) Focus: Remembering / Understanding	Tier 2: Established (Practitioner) Focus: Applying/Analyzing	Tier 3: Advanced (Expert) Focus: Evaluating/Creating	Smart Classroom Link
Pedagogical Intelligence, Communication and Learning Orchestration	Static host for files (PDF/PPT); basic textual messaging threads; manual web links.	LTI integrations active (Zoom/Meet); automatic transcription logs; native API chat co-pilots for group spaces.	Private, secure on-premise and cloud AI services orchestrating intelligent tutoring loops and real-time personalized study paths.	Provision 2: AI-driven AV capture, PTZ tracking, noise cancellation - LMS synchronization.
Open Educational Resources, Knowledge Co-Creation and Digital Content Innovation	Unstructured storage directories; no digital license tracking or CC metadata attributes.	Native CC tagging interface; integrated H5P content creator suite; basic text refinement tools built into LMS editor.	Semantic indexing libraries; automatic student portfolio asset extraction; multi-agent AI verification for source provenance.	Provision 3: LMS integration (OER/CC), H5P authoring, Zotero citation validation.
Assessment & Analytics	Standard multiple-choice engines; simple text box comments;	Advanced rubrics matrices; audio/video grade book capture tools; aggregated LMS	Localized predictive analytics dashboards; pattern-recognition tools	Provision 3: Real-time formative tools, LMS exit tickets, analytics.

	manual calculation charts.	tracking logs per student.	for structural error detection with automated prompt suggestions.	
Sovereign Accessibility	Standard responsive web scaling without adaptive content optimisation; simple password encryption.	Full compliance with WCAG 2.2 AA standards; multi-format download capabilities (audio MP3, ePub); enforced 2FA protection.	Implementation of graceful degradation Architecture for spatial assets and dynamic UDL presentation layers, fully verified under simulated throttled network testing metrics, automated localized language subtitling; closed-loop zero-data-leakage architecture.	Provision 4: Text-to-speech, live captioning, accessible desks; Provision 4.2: Mobile-first offline resilience
Human-in-the-Loop (HITL) Platform Governance	Basic or automated execution of routine grading and platform assessments without built-in explanation layers or mandatory human verification overrides.	Active integration of basic explanatory notices alongside system analytics (Auditable AI); availability of foundational instructor-led manual override and review tools within the grading module.	Fully operationalised HITL governance featuring autonomous, immutable audit trails for all predictive triggers, backed by mandatory multi-signature digital authorisation workflows for institutional actions.	Provision 2 & 3: AI tools require human pedagogical oversight per smart classroom operational guardrails.

4. Key Performance Indicators (KPIs) for System Validation

To secure institutional certification under the eCAMPUS project scope, platforms and integrated smart classroom systems must meet these specific, quantifiable metrics:

KPI	Target	Smart Classroom Link
AI & XR Explainability	100% of AI utilities show "View Logic" link to admins and educators.	Aligns with Provision 2: AI-powered PTZ/NLP must expose decision logic to instructors.
Universal Inclusivity Score	0 WCAG 2.2 AA errors (Axe/Lighthouse); 100% XR modules provide 2D fallback + spatial TTS.	Aligns with Provision 4: assistive tech, captioning, adjustable desks.
OER & 3D Asset Openness	≥ 30% of instructional objects and 3D/AR/VR assets carry indexed CC licensing.	Aligns with Provision 3: LMS OER curation and metadata engine.
XR Mobile Resilience	< 3.5 s / < 2 MB core load; XR initiates in 2 s (Wi-Fi 6/5G) and 6 s (4G < 5 Mbps) with LoD streaming.	Aligns with Provision 1: Wi-Fi 6/Private 5G; IoT bandwidth optimization.
Data Sovereignty	AES-256 at rest, TLS 1.3 in transit; 100% on-premises or national private cloud; zero external data transit.	Aligns with Provision 3: LMS routes recordings exclusively through institutional firewalls.

5. Implementation Roadmap for Higher Education Institutions

This framework provides the standardised metrics necessary to elevate e-learning from a mere repository of files to a dynamic, secure, and inclusive educational ecosystem. **Next Step:** Develop the self-assessment toolkit (questionnaires and automated scanning scripts) to test the platform against these benchmark standards.

Phase 1: Diagnostic Assessment & LTI Architecture Verification

- **Action:** Run automated accessibility scans on existing Learning Management Systems (e.g., Moodle, Canvas instances). Map current plugin frameworks against the requirements of the 4+1 Model and verify compatibility with Smart Classroom Hardware Telemetry LTI (Domain 1.4).
- **Deliverable:** System Gap Analysis Report detailing compatibility with DigiComArm.

Phase 2: Secure API Mesh Integration & Content Modernization

- **Action:** Provision secure, tokenized API hooks connecting the LMS to authorized LLM endpoints, making sure data privacy protocols are active. Enforce Creative Commons fields inside the file-uploader module. Enable inline H5P authoring tools. Integrate LMS with smart classroom AI-Driven AV Capture Systems (Provision 2) for automatic lecture upload.
- **Deliverable:** Certified Platform Beta Version with active UDL accessibility layers and content protection guardrails.

Phase 3: Analytics Calibration & Full Governance Deployment

- **Action:** Train predictive analytics systems on local student performance patterns while establishing strict Human-in-the-Loop review rules. Run comprehensive, multi-stakeholder pilot courses to gather performance data and calibrate system responsiveness against the KPI targets defined in Section 4.
- **Deliverable:** Fully deployed, DigiComArm-compliant institutional learning platform ready for nationwide quality assurance validation.

6. Quality Assurance, Continuous Improvement and Sustainability

Quality assurance mechanisms will continuously support the framework, facilitating both compliance and sustainability within the institutions. These will consist of annual benchmarking, accessibility reviews, surveys, learning analytics evaluations, and external evaluations by experts to confirm that it meets all required criteria for pedagogy, technology, and accessibility.

For sustainable use of the framework after the end of the grant period, it is essential for the institutions to develop sustainability frameworks through appropriate governance models, budgeting for operations and maintenance, capacity building for teachers and other relevant staff members, and regular framework reviews.