



Open Educational Resources and Generative AI: Towards a Framework for Responsible Integration

RESEARCH ARTICLES

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ABSTRACT

Generative artificial intelligence is challenging traditional approaches to the production, adaptation, circulation, and governance of educational resources. This article asks how generative artificial intelligence and Open Educational Resources can be responsibly integrated in higher education and lifelong learning. The study adopts a qualitative framework-development design organised in two phases: an integrative analysis of international artificial intelligence and OER frameworks, and a stakeholder-informed co-creation phase comprising expert validation and a participatory workshop. Data sources included a documentary framework review matrix, expert validation transcripts, panel synthesis notes, workshop group outputs, graphical materials, and facilitator notes. The stakeholder-informed phase involved five international experts, four national informants, and 81 workshop participants from educational, governmental, civil society, and open-knowledge backgrounds. Data were analysed through abductive thematic synthesis, source-to-theme mapping, and iterative framework refinement. The findings show that: (a) artificial intelligence and open educational resources continue to evolve through partially separate policy and practice spheres, creating gaps in equity, interoperability, provenance, trust, legal clarity, and institutional capacity; (b) responsible implementation depends on human agency, openness beyond licensing, quality assurance, collective governance, capacity-building, and infrastructure choice; (c) co-creation translated these gaps into practical institutional priorities; and (d) the OE-AI Framework offers a seven-pillar architecture for aligning AI-mediated innovation with openness, educational autonomy, and public value. The article contributes a governance-oriented framework for educational communities, policymakers, and institutional leaders seeking to integrate AI and OER as a public-good educational challenge.

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The confluence of generative artificial intelligence (GenAI) and Open Educational Resources (OER) has opened a big debate about the transformation of higher education (HE) and lifelong learning (LLL). GenAI is frequently advertised as an enabler of personalisation, adaptive feedback, translation, metadata generation, resource recombination, and new forms of pedagogical mediation (Holmes et al., 2022; UNESCO, 2024a, 2024b). OER, instead, has developed from a rights-based and commons-oriented tradition in which openness is linked to access, reuse, equity, collaboration, and education as a public good (Organisation for Economic Co-operation and Development) (OECD, 2015; UNESCO, 2011, 2019b, 2024c). Although these agendas are complementary, they have been governed through separate philosophical, pedagogical, policy, technical, and institutional trajectories.

This separation matters because GenAI changes educational resources in ways that exceed the acceleration of content production. Resources are increasingly generated, recombined, translated, sequenced, recommended, and adapted through proprietary interactive and platform-mediated systems (Al Abri et al., 2025; Ding, 2025; Li et al., 2023). These developments raise concerns about authorship, ownership, intellectual property, privacy, bias, explainability, accessibility, platform dependency, and the role of cloud infrastructures and foundation models in shaping educational environments (Agarwal & Aston, 2024; Bozkurt, 2023, 2024; De Andrade et al., 2023). They also challenge narrow accounts of AI as an efficiency tool by foregrounding the conditions under which educational knowledge is produced, validated, attributed, shared, and governed.

Recent works have begun to examine the relationship between AI, OER, and open educational practices (OEP). AI-augmented OER lifecycle models, AI-supported OEP, synthetic content, modular OER for AI education, and the risks of generative AI for open knowledge ecosystems have been widely analysed (Bozkurt, 2023; Gillet et al., 2024; Rampelt et al., 2025; Tlili & Burgos, 2024; Tlili et al., 2026). However, the literature remains dispersed across ethics, competencies, licensing, repository infrastructures, open pedagogy, and educational technology governance. Existing instruments offer important components, but there is still a need for an integrative framework that connects AI-mediated resource production with the values, rights, practices, and infrastructures of open education (OE).

This problem is especially relevant for HE and LLL because institutions are increasingly expected to respond to resource constraints, multilingual provision, widening participation, continuous reskilling, and the rapid renewal of professional knowledge. In such conditions, AI-enabled resource production appears attractive because it promises speed, adaptation, and scale (Kim & Koo, 2026; Marchena Sekli, Godo, & Véliz, 2024; Mavundla et al., 2025). However, these promises cannot be separated from the institutional culture environments through which educational resources are authored, validated, attributed, stored, recommended, and reused. The intersection of GenAI and OER therefore raises a question of educational governance: how can institutions benefit from AI-mediated resource production while preserving the principles of openness, transparency, accountability, accessibility, and public value that have historically shaped OE?

The article approaches this question by treating AI-OER integration as a structural transformation of educational resources instead of as the adoption of isolated tools. From this perspective, the resource is not only a text, object, or learning asset. It becomes part of a wider socio-technical environment that includes prompts, models, datasets, metadata, licences, human review procedures, repository infrastructures, platform interfaces, procurement decisions, and institutional policies. This broader understanding is necessary because the risks of opacity, dependency, bias, and enclosure do not arise only at the level of individual use.

Against this background, the article addresses the following research question: How can generative AI and OER be responsibly integrated in HE and LLL? The article defines responsible AI-OER integration as the institutional alignment of AI-mediated resource production, adaptation, validation, circulation, and governance with openness, equity, human agency, transparency, quality assurance, accountability, and public value. The study develops the OE-AI Framework through two complementary forms of evidence: an integrative analysis of international AI and OER frameworks and stakeholder-informed thematic synthesis based on expert validation,

thematic panels, and participatory co-creation activities. The article first reviews the relevant literature, then presents the methodological design, findings, discussion, and implications for research and practice.

LITERATURE

AI AND OER AS PARALLEL POLICY AND GOVERNANCE DOMAINS

GenAI and OER have both gained strategic importance in HE and LLL, although their development has followed different trajectories. AI frameworks have generally been structured around ethics, competencies, human-centred design, data protection, and future readiness (OECD, 2019; UNESCO, 2019a, 2021, 2024a, 2024b). OER frameworks have emerged from a rights-based and commons-oriented tradition in which openness is associated with access, reuse, collaboration, sustainability, and the democratisation of knowledge (OECD, 2015; UNESCO, 2011, 2019b, 2024c). The distinction is important since AI frameworks often devote limited attention to knowledge commons, while OER frameworks have not yet sufficiently addressed algorithmic mediation, adaptive systems, and AI-enabled content generation.

At the operational level, the two domains prioritise different mechanisms. AI guidance tends to focus on ethical principles, institutional readiness, educator and learner competencies, transparency, and responsible deployment (OECD, 2019; UNESCO, 2019a, 2021, 2024a, 2024b). OER guidance gives greater attention to open licensing, repository infrastructures, accessibility, capacity-building, international cooperation, and quality assurance (OECD, 2015; UNESCO, 2011, 2019b, 2024c). The result is a fragmented landscape in which GenAI may be discussed without adequate attention to whether the resources it generates or mediates remain open, attributable, reusable, and contestable, while OER may be addressed without sufficient attention to the systems that shape visibility, recommendation, adaptation, and data flows.

The political implications of this parallel development are significant. If GenAI and OER continue to be governed separately, their confluence will further reproduce forms of opacity and enclosure that both fields seek to address. Equity may remain declarative rather than structural, metadata standards may be insufficiently prepared for AI-mediated environments, provenance and licensing may remain underdeveloped, quality assurance may not scale across AI-assisted workflows, legal uncertainty may inhibit responsible experimentation, and capacity-building may remain divided between AI literacy and OER literacy (Affordable Learning Georgia, 2024; Bozkurt, 2023; OECD, 2015, 2019; UNESCO, 2019b, 2021, 2024a, 2024c). AI-OER convergence should therefore be understood as a governance challenge instead of as a purely technical innovation.

The disconnection between these two domains also limits the practical usefulness of existing guidance for institutions. GenAI frameworks can help institutions identify ethical principles, professional competencies, or risk-management processes, but they do not always specify how AI-generated or AI-mediated educational content should remain open, reusable, attributable, and pedagogically trustworthy. OER frameworks, in turn, provide strong principles for licensing, sharing, reuse, and institutional policy, but they were largely designed for a landscape in which educational resources were more stable, human-authored, and repository-based, thus, the emergence of such systems requires a closer dialogue as the governance of AI-mediated OER depends simultaneously on the ethics of AI and the public-goods commitments of OE.

GENERATIVE AI AND THE TRANSFORMATION OF EDUCATIONAL RESOURCES

GenAI transforms educational resources by changing the relations among production, format, pedagogy, governance, and political economy. In the production of resources, GenAI systems can support drafting, translation, summarisation, enrichment, adaptation, and tagging. In the format of resources, content increasingly appears as modular, interactive, conversational, and dynamically recombined material instead of as a fixed artefact. In pedagogical interaction, intelligent tutoring systems, chatbots, virtual assistants, adaptive textbooks, and AI-generated pedagogical agents create new forms of feedback, dialogue, and sequencing (Han et al., 2025; Li et al., 2023; Nazaretsky et al., 2022). These possibilities can expand access and responsiveness, but they also unsettle assumptions about coherence, attribution, curricular commonality, and pedagogical control.

A shift from organic to synthetic content in OER and OEP is being produced by GenAI, thereby making quality, reliability, privacy, access, ownership, and co-creation central to openness, highlighting the challenges of authorship, ownership, academic ethics, and transparent reporting in AI-assisted academic and educational work (Bozkurt, 2023, 2024). A collective manifesto cautions that generative AI is not a neutral instrument and calls attention to human agency, bias, values, and ethical responsibility (Bozkurt et al., 2024). Therefore, AI-OER convergence must be governed as a socio-technical transformation of open knowledge, not only as a set of tools for content creation.

The transformation also has implications for the development of AI literacy and OE capacity. Teacher-in-the-loop approaches further suggest that AI-supported OER adaptation should strengthen educator agency and pedagogical judgement (Balaji et al., 2025). Educators can partner with GenAI to develop and adapt open digital content while maintaining pedagogical responsibility (van den Berg, 2024) and demonstrate that educators using OER for AI education value suitable, high-quality, accessible, and often modular resources, which suggests that openness must be operationalised through usable and trustworthy formats (Rampelt et al., 2025). AI education frameworks need to connect foundations, integration, innovation, and citizenship (Mahmud et al., 2025). These studies indicate that professional capacity, resource quality, and institutional governance are mutually dependent.

Educational resources are undergoing a double movement. On one hand, AI can increase the availability of learning materials by lowering the threshold for drafting, translating, adapting, and enriching content. On the other hand, the same processes may obscure the origins, quality, assumptions, and legal status of the materials being circulated. In OER, openness has traditionally been linked to the possibility of inspecting, adapting, and redistributing resources. In AI-mediated environments, inspection becomes more complex because the relevant object of scrutiny is not only the output but also the workflow through which the output was produced. For this reason, responsible openness must include documentation of sources, human contributions, AI assistance, validation procedures, and limitations.

Therefore, a shift from resource availability to resource trustworthiness needs stressing. Access remains fundamental, particularly in contexts marked by inequality, linguistic diversity, and limited institutional capacity. However, access to a poorly attributed, weakly validated, inaccessible, or legally uncertain resource cannot be understood as sufficient openness. The same applies to AI-generated resources that are easy to produce but difficult to evaluate, adapt, or sustain. A responsible framework must therefore connect the classic OER questions of access, reuse, and licensing with the AI-related questions of explainability, provenance, bias, data governance, and human oversight.

RESPONSIBLE CONVERGENCE: OPENNESS, QUALITY, INFRASTRUCTURE, AND PUBLIC VALUE

Responsible AI-OER convergence requires a broader understanding of openness than licensing alone and a broader understanding of responsibility than individual ethical conduct. Open licences remain necessary because they establish rights to access, use, adapt, and share resources. However, AI-mediated environments require additional mechanisms for provenance, attribution, disclosure, explainability, pedagogical validation, accessibility, and institutional accountability (Affordable Learning Georgia, 2024; Bozkurt, 2023; Tlili et al., 2026). This expanded view does not weaken the OER tradition. Rather, it extends it to the conditions under which resources are generated, reviewed, localised, recommended, and sustained.

Recent work on AI and OER illustrates both convergence and difference. Gillet et al. (2024) propose an implementation framework for AI-augmented OER oriented towards the lifecycle of resources and platform-supported learning experiences. Tlili and Burgos (2024) position AI as a possible catalyst for OEP, while also raising questions about where institutions should begin. Duan (2026) reviews and compares OEP models and argues for updated frameworks in the AI era. Li (2025) proposes a layered framework for sustainable OER in digital-intelligence contexts. These works move the field forward, while their emphases differ: some focus on implementation and lifecycle management, others on open practice, competence, sustainability, or platform functionality. This article, hence, contributes by integrating these streams into a governance-oriented framework that links public value, human agency, rights, quality, metadata, accessibility, and monitoring.

Infrastructure is an indispensable dimension of responsible convergence because openness cannot remain viable if it is detached from the technical and economic systems through which resources are generated and circulated. Platform dependence, proprietary models, data extraction, closed recommendation systems, and procurement arrangements can limit educational autonomy even when individual resources are formally open (De Andrade et al., 2023; Grimaldi et al., 2025). AI-OER integration should therefore be treated as a question of public value, collective stewardship, and institutional responsibility. The central issue is not whether AI can generate or adapt educational resources, but under what governance conditions such uses strengthen the knowledge commons rather than intensifying dependency and enclosure.

METHODS

RESEARCH METHOD AND DESIGN

This study adopted a qualitative framework-development design. The purpose was to examine how GenAI and OER can be responsibly integrated in HE and LLL and to translate the analysis into a structured framework for institutional use. The study was interpretive in orientation and focused on the relationships among openness, governance, quality assurance, human agency, professional capacity, infrastructure, and education as a public good.

The research was organised in two phases. Phase 1 consisted of an integrative analysis of international frameworks, recommendations, guidelines, and scholarly contributions on AI, OER, digital education, competencies, ethics, licensing, and responsible innovation. Phase 2 consisted of stakeholder-informed co-creation, including expert validation and a participatory workshop. The analysis was abductive and iterative: preliminary categories derived from the documentary corpus were examined against stakeholder-informed evidence, while stakeholder concerns were used to refine, extend, and reorganise the emerging framework (Miles & Huberman, 1994; Timmermans & Tavory, 2012).

The design was selected because the object of study was not a bounded intervention with predetermined outcomes, but an emerging field of practice in which conceptual, policy, technical, and institutional dimensions remain in formation. Framework development was therefore appropriate since it allowed the study to identify existing orientations, compare their assumptions, and translate them into a structured model capable of informing practice. The design also allowed the analysis to remain open to stakeholder interpretation, since responsible integration cannot be defined only from documentary sources or policy instruments. It must be examined in relation to the concerns of those who design, govern, teach with, disseminate, and use educational resources.

The study develops a situated, theoretically informed and stakeholder-refined framework that can support institutional deliberation and future empirical testing. The framework should therefore be read as a structured synthesis of evidence and judgement. This orientation is consistent with qualitative framework-development approaches in which documentary analysis, expert validation, and participatory synthesis are used to construct a conceptual and operational basis for action.

DATA COLLECTION TOOLS

Data collection and initial data reduction were supported by two author-developed matrices that functioned as analytical scaffolds linking the documentary corpus, stakeholder evidence, and the final OE-AI Framework (see Appendix A and B). The first, a framework review matrix, was used in the documentary phase to compare AI, OER, OE, and digital education policy documents across shared analytical fields. Its structure was informed by the literature review and by recurrent domains in international AI and OER guidance, including ethics, openness, governance, competence, licensing, equity, quality assurance, metadata, provenance, and infrastructure. The matrix recorded bibliographic information, domain, normative orientation, operational components, methodological logic, scope or level of action, treatment of openness and AI, equity and accessibility, licensing, provenance, quality assurance, metadata, capacity-building, infrastructure, and identifiable gaps. During the coding process, the matrix was refined to distinguish between normative principles and operational mechanisms, individual and institutional responsibility, and the level at which implementation was expected to occur. This

enabled the analysis to compare not only the themes addressed by each document, but also how each framework conceptualised responsible educational action.

The second tool, a stakeholder synthesis matrix, was developed after the initial documentary analysis to organise qualitative evidence from the expert validation and participatory co-creation activities conducted in Bilbao, Spain, in December 2025. This matrix recorded the evidence source, contributor group, recurrent concern, illustrative contribution, related documentary gap, emergent thematic dimension, implication for the framework, and level of action. Its purpose was to preserve traceability between stakeholder inputs and framework-development decisions. For example, concerns about AI-generated authorship were linked to documentary gaps in provenance and licensing; concerns about dominant platforms were linked to infrastructure and collective governance; and concerns about teacher responsibility were linked to human agency, professional judgement, and pedagogical validation. In this way, the matrix supported data reduction while also documenting how expert and workshop contributions refined the transition from documentary gaps to the final OE-AI Framework pillars.

SAMPLING

The documentary corpus was selected purposively as the study aimed to develop an integrative framework. Documents were included when they addressed AI in education, OER, OE, digital public goods, ethical AI, competencies, licensing, provenance, interoperability, repository practices, accessibility, educational governance, or the emerging intersection between AI and OER. The corpus included international policy instruments, institutional and practice-oriented guidelines, technical and legal resources, and recent scholarly publications relevant to AI-OER convergence.

The stakeholder-informed component used purposive, criterion-based sampling to include actors with recognised scientific, professional, institutional, or practitioner experience in areas relevant to responsible AI-OER integration. The purpose was to bring together complementary forms of expertise and situated knowledge. This strategy allowed the study to examine the conceptual robustness, transnational relevance, and practical applicability of the emerging OE-AI Framework.

The expert validation process involved five international experts from France, Spain, Portugal, Brazil, and the United Kingdom. They were selected due to their scientific and professional trajectory in OE, OER policy, AI and digital education, educational technology, accessibility, HE innovation, ILLL, and open knowledge systems. Their combined profiles provided complementary perspectives from European and Latin American research, policy, and institutional innovation networks. To preserve confidentiality, experts are not named individually; however, their profiles are characterised as follows: one expert had an established academic trajectory in OE and OER policy; one had recognised experience in digital learning, institutional innovation, and educational technology; one contributed expertise in AI, data-informed education, and emerging learning technologies; one brought a policy-oriented perspective on open knowledge, digital transformation, and public-interest infrastructures; and one had substantial experience in HE innovation, international cooperation, and capacity-building.

The participatory process was conducted in Bilbao, Spain, in December 2025, and included a thematic panel and a co-creation workshop. The panel, entitled “Challenges and Practices in the Creation of Educational Resources in the Era of AI”, involved five national informants with experience in educational technology, techno-pedagogical innovation, public educational support systems, adult literacy and bilingual education, HE, digital culture, and open knowledge advocacy. The workshop involved 81 participants, including primary, secondary, and university teachers, representatives of public bodies, civil society organisations, advocates, and other education stakeholders.

The distinction between experts, informants, and workshop participants was maintained throughout the analysis. Experts contributed to conceptual validation of the preliminary framework; informants provided situated sectoral and institutional perspectives; and workshop participants introduced practical priorities, perceived risks, and implementation needs. The materials generated through expert interviews, panel contributions, group outputs, graphical productions and plenary discussion notes were compared with the documentary corpus to identify convergences, divergences, and refinements that informed the final OE-AI Framework.

During Phase 1, the framework review matrix was used to organise and compare documents across four common dimensions: normative orientation, operational components, methodological logic, and scope or level of action. Normative orientation referred to the values and policy goals promoted by each document. Operational components referred to proposed tools, competencies, standards, guidelines, action areas, or governance mechanisms. Methodological logic referred to the way implementation was envisioned, for example through policy alignment, institutional reform, capacity-building, technical standardisation, advocacy, community practice, or iterative experimentation. Scope and level of action referred to whether the instrument operated primarily at global, regional, national, institutional, repository, or practice-based levels.

The document analysis was organised around six iterative-abductive analytical movements. AI frameworks were examined in relation to ethics, human-centred design, teacher and student competencies, policy readiness, transparency, data protection, and institutional responsibility, while OER frameworks were analysed in relation to open licensing, equitable access, repository infrastructures, quality assurance, capacity-building, sustainability, and international cooperation. Instruments and studies explicitly addressing the intersection between AI and OER were then used to test whether existing guidance already offered an integrated architecture for responsible convergence. Across these materials, the analysis moved repeatedly between domain-specific emphases, areas of convergence and divergence, and their implications for AI-OER integration. This recursive comparison enabled the identification of critical gaps concerning equity, metadata, provenance, licensing, quality assurance, legal clarity, infrastructure, and capacity-building, which were subsequently translated into preliminary framework categories.

In Phase 2, expert validation examined the assumptions, tensions, and normative commitments of the preliminary framework. The expert discussions were audio-recorded, transcribed, and analysed thematically. The workshop generated group productions, graphical materials, facilitator notes, and plenary synthesis. These materials were entered into the stakeholder synthesis matrix and analysed through abductive thematic synthesis. Coding combined deductive attention to the preliminary categories with inductive attention to concerns raised by experts, informants, and participants (Braun & Clarke, 2006). Codes were clustered into six cross-cutting dimensions: human agency, responsibility, and educational autonomy; openness beyond licensing; quality, verification, and trust; infrastructure and collective governance; competence development and pedagogical redesign; and transition, experimentation, and public-interest futures.

The thematic analysis aimed to identify conceptually significant relations among documentary gaps, expert interpretations, and stakeholder priorities. Through iterative comparison across the documentary corpus, expert validation, panel contributions, and workshop outputs, recurrent concerns were examined in relation to the emerging framework. Source-to-theme mapping and research team discussion supported the interpretation of evidence and helped clarify how the six cross-cutting dimensions informed the seven OE-AI Framework pillars.

The thematic synthesis followed abductive logic, combining attention to categories derived from the documentary review with openness to themes emerging from stakeholder-informed evidence. Deductive attention was given to categories derived from the documentary review, including: openness, ethics, licensing, quality, metadata, provenance, capacity-building, and infrastructure. Inductive attention was given to themes that emerged through expert and workshop evidence, including: responsibility as answerability, openness as stewardship, AI authorship as an unstable category, institutional transition as a gradual process, and public-interest futures as a collective governance concern. The final themes emerged through movement between prior frameworks and stakeholder interpretation. To strengthen analytical transparency, emergent themes were examined in relation to three interconnected dimensions: the documentary gaps or conceptual tensions they addressed, the stakeholder-informed evidence that supported or challenged them, and their implications for the evolving structure of the OE-AI Framework.

VALIDITY AND RELIABILITY MEASURES

The study incorporated several strategies to support rigour and transparency in the analytical process through triangulation across documentary and stakeholder-informed sources (Lincoln & Guba, 1985). Documentary evidence, expert validation transcripts, panel contributions,

workshop outputs, and graphical productions were compared to identify recurrent patterns and points of divergence across sources. The framework review matrix and stakeholder synthesis matrix provided common parameters for organising the material and for documenting the relationship between evidence, themes, and framework pillars. Source-to-theme mapping also helped distinguish findings derived from the documentary corpus from interpretations informed by expert and stakeholder contributions. Reflexivity was considered by recognising the authors' situated perspective within open education and by examining the adequacy of existing OER principles under AI-mediated conditions. During the participatory workshop, plenary synthesis offered an opportunity for participants to confirm, qualify, or challenge priorities, while the expert validation sessions provided critical feedback on the preliminary framework.

This study was developed under protocol P-IFE-202506-002, with approval granted on 7 August 2025 by the *Comité Institucional de Ética en Investigación* (CIEI) of Tecnológico de Monterrey. Participants were informed about the purpose of the study, the voluntary nature of their participation, and the use of the data generated through expert validation, panel, and workshop activities. Informed consent was obtained prior to participation, including consent for audio recording where applicable. Contributions were analysed confidentially, and experts and informants are described by role or area of expertise.

FINDINGS AND DISCUSSION

STRUCTURAL GAPS IN CURRENT AI-OER CONVERGENCE

The integrative framework analysis showed that AI and OER frameworks converge around: *equity, inclusion, lifelong learning, teacher empowerment, international cooperation, and responsible innovation*. However, they diverge in their underlying assumptions and operational mechanisms. AI frameworks tend to emphasise: *ethics, competencies, future readiness, data governance, and responsible deployment*, while OER frameworks tend to emphasise: *openness, licensing, access, reuse, collaboration, and the knowledge commons*. This divergence produces structural gaps when AI becomes involved in the production, adaptation, recommendation, and circulation of OER.

The first finding is therefore diagnostic. AI and OER frameworks share broad educational ambitions, but they distribute responsibility differently and make different assumptions about the object being governed. AI frameworks tend to focus on: *ethical use of technologies, the development of competencies, and the management of risk in educational settings*. OER frameworks tend to focus on: *openness, accessibility, licensing, reuse, and sustainability of resources*. The analysis showed that responsible AI-OER integration requires these orientations to be connected because AI-mediated educational resources are simultaneously understood as: *technological outputs, pedagogical artefacts, legal objects, data-mediated entities, and components of institutional knowledge infrastructures*.

The most significant gap is the absence of a coherent lifecycle perspective. Documents often addressed moments in the lifecycle of educational resources, such as: *creation, licensing, sharing, quality assurance, or use*. However, *AI-mediated resources move through a more complex lifecycle that includes: prompt design, model selection, source selection, generation, editing, validation, attribution, metadata enrichment, repository publication, recommendation, localisation, analytics, and subsequent adaptation*. Without a lifecycle view, institutions may adopt AI tools for resource production while leaving unresolved the later questions of provenance, accessibility, review, reuse, and monitoring.

Table 1 summarises the main gaps identified in the documentary analysis and the implications these gaps had for framework construction.

STAKEHOLDER VALIDATION AND CO-CREATION PRIORITIES

The stakeholder-informed phase refined the preliminary categories by connecting documentary gaps with situated educational concerns. Experts emphasised that OER should be understood “*within a broader tradition of human rights, public goods, and collective stewardship*”. They also argued that “*human agency in AI-mediated educational environments cannot be reduced to the formal presence of a human reviewer*”. Agency was associated with: *responsibility, judgement, integrity, and answerability*. This interpretation strengthened the framework's focus on educational autonomy and professional responsibility.

GAP	EVIDENCE FROM THE FRAMEWORK ANALYSIS	IMPLICATION FOR OE-AI FRAMEWORK
Declarative equity	AI and OER policy instruments commonly affirm equity and inclusion, but they do not always specify how accessibility, multilingual localisation, and low-resource contexts should be operationalised in AI-mediated resource workflows.	The framework includes accessibility, localisation, and public value as implementation conditions rather than optional add-ons.
Metadata and interoperability	OER frameworks address repositories and reuse, while AI guidance rarely specifies machine-actionable metadata for provenance, adaptation, recommendation, or automated discovery.	The framework treats metadata and discovery as a governance pillar linked to interoperability and transparency.
Provenance, attribution, and licensing	Generative AI complicates assumptions about identifiable authorship, training data, derivative works, prompt-based production, and licence compatibility.	The framework includes rights and provenance as a pillar covering disclosure, attribution, licensing, and traceability.
Quality, verification, and trust	Ethical AI principles and OER quality guidance remain weakly connected to scalable pedagogical validation procedures for AI-assisted resources.	The framework requires human review, pedagogical validation, verification workflows, and auditable quality assurance.
Legal and institutional accountability	Existing guidance often identifies risks but provides limited institutional mechanisms for assigning responsibility across educators, repositories, platforms, and decision-makers.	The framework includes collective governance and accountability as a pillar linked to roles, procurement, and institutional policy.
Fragmented capacity-building	AI literacy and OER literacy are frequently treated as separate professional development agendas.	The framework links human agency and competence development to AI-assisted authoring, critical judgement, and OEP.
Infrastructure dependency	AI-OER implementation is shaped by platform ownership, cloud infrastructures, data flows, and procurement models that may conflict with public-interest openness.	The framework connects infrastructure choice, monitoring, and sustainability to educational autonomy and commons stewardship.

Table 1 Structural gaps in current AI-OER convergence and implications for the framework.

In the expert validation, human agency emerged as one of the strongest themes. Experts did not define agency as the mere presence of a human user within an automated workflow. They associated it with *“responsibility, integrity, professional judgement, and answerability”*. This interpretation extended the common language of human oversight by emphasising that *“educators and institutions must retain the capacity to make meaningful decisions about whether, how, and why AI is used in the production or adaptation of OER”*. The theme also showed that responsibility *“cannot be delegated to the individual educator alone; it requires institutional policies, review processes, and collective governance arrangements”*.

The expert validation further showed that *“GenAI destabilises inherited OER assumptions”*. Traditional OER models often presume an identifiable creator who exercises meaningful control over resource production. Prompt-based systems complicate this premise because parts of the production process occur within opaque infrastructures. This concern did not diminish the relevance of OER. Rather, it showed the need to rethink provenance, attribution, authorship, and licensing under AI-mediated conditions.

This destabilisation was particularly evident in relation to authorship and provenance. Traditional OER workflows assume that a resource can normally be traced to identifiable human authors and source materials. In AI-assisted workflows, relevant stages of production may involve prompts, training data, model outputs, automated rewriting, translation, or adaptation. Participants therefore emphasised that *“provenance should be understood as a workflow issue and not only as a citation issue. It should document the origin of content, the nature of AI assistance, the human decisions that shaped the resource, the licence status of source materials, and the validation steps undertaken before publication or reuse”*.

The participatory workshop translated these conceptual concerns into practical priorities. Participants emphasised the need for “understandable guidance, gradual institutional transition, role-specific responsibilities, quality review, disclosure practices, educator capacity-building, accessibility, and experimentation under public-interest conditions”.

Workshop participants gave particular importance to implementation pathways. Rather than presenting responsible AI-OER integration as a fixed end state, participants described it as “a process of institutional transition requiring experimentation, guidance, professional development, and shared criteria”. This emphasis is important because institutions differ considerably in digital maturity, repository capacity, legal support, language needs, and professional development structures. A framework for AI-OER integration must therefore be sufficiently structured to guide action but sufficiently flexible to allow local adaptation.

The workshop also highlighted the need for practical instruments that translate principles into institutional routines. Participants identified the value of “checklists for AI disclosure, quality-review protocols, accessibility criteria, licensing guidance, metadata fields, repository workflows, and examples of acceptable and unacceptable uses”. These priorities indicate that the framework should not remain at the level of broad principles. It should support the development of institutional workflows that make responsibility visible in everyday decisions concerning resource production, adaptation, validation, publication, and reuse. Table 2 presents the main stakeholder findings and their implications for the framework.

THE OE-AI FRAMEWORK

The OE-AI Framework translates the documentary analysis and stakeholder-informed findings into a seven-pillar architecture for responsible AI-OER integration. The framework was developed as a synthesis of the documentary diagnosis and stakeholder-informed refinement. It responds to the structural gaps identified in the corpus by specifying the areas that institutions need to address when AI is used in relation to OER. It also responds to the stakeholder evidence by giving central place to human agency, openness beyond licensing, quality and trust, collective governance, competence development, infrastructural choice, and public-interest futures. The seven pillars should therefore be understood as interdependent rather than sequential. Weakness in one pillar affects the others: for example, poor provenance weakens quality verification, weak metadata limits discovery and reuse, and inadequate governance reduces the possibility of meaningful human agency. Figure 1 presents the framework which functions as the central visual synthesis of the study. The seven pillars are not sequential steps. They represent interdependent governance conditions that should be considered across the lifecycle of AI-mediated educational resources.

The framework extends beyond existing AI and OER instruments by integrating three elements that are often treated separately: *the OER lifecycle, the institutional governance of AI, and the public-interest conditions of educational infrastructure*. It therefore treats AI-OER integration as a matter of institutional design rather than as a tool-use decision made only by individual educators. Following, a description of each pillar is introduced.

STAKEHOLDER FINDING	FRAMEWORK IMPLICATION
Human agency, responsibility, and educational autonomy	Human oversight must involve professional judgement, pedagogical responsibility, and accountable decision-making, not only approval of outputs.
Openness beyond licensing	Open licensing remains necessary, but openness must also include stewardship, accessibility, adaptability, provenance, and sustainability.
Quality, verification, and trust	Institutions require procedures for reviewing conceptual accuracy, pedagogical alignment, bias, accessibility, and source transparency.
Infrastructure and collective governance	AI-OER adoption must address platform dependency, procurement, interoperability, institutional roles, and collective accountability.
Competence development and pedagogical redesign	Educators need integrated AI and OER literacies, including prompting, evaluation, licensing, attribution, accessibility, and open pedagogy.
Transition, experimentation, and public-interest futures	The framework should support progressive adoption, local experimentation, and institutional pathways rather than a single universal model.

Table 2 Stakeholder findings and framework implications.

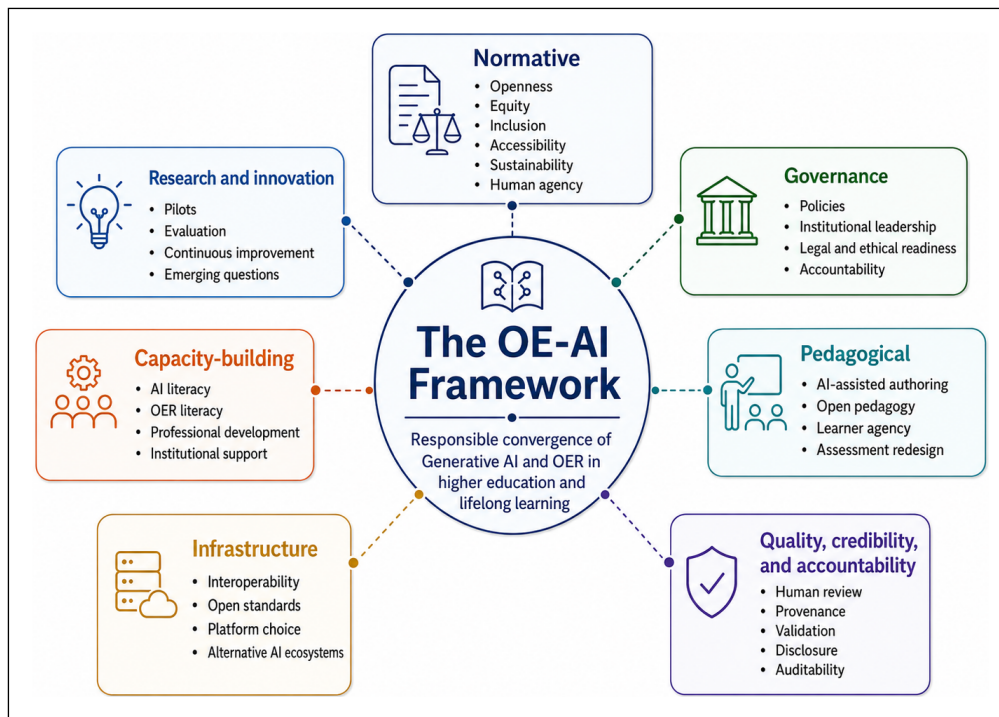


Figure 1 OE-AI Framework for responsible AI-OER integration.

- Normative orientation and public value: AI-OER integration should be grounded in education as a public good, equity, inclusion, openness, sustainability, and institutional responsibility. This pillar prevents AI adoption from being evaluated only through efficiency, scale, or innovation rhetoric.
- Collective governance and accountability: Institutions require policies, role definitions, review responsibilities, procurement criteria, risk-management procedures, and participatory governance mechanisms. Responsibility should not be displaced onto individual educators when risks are produced by platforms, infrastructures, or institutional choices.
- Human agency in AI-assisted authoring: Educators, learners, librarians, instructional designers, and communities should retain meaningful agency in defining purposes, selecting tools, reviewing outputs, adapting resources, and making pedagogical decisions. Human agency includes judgement, responsibility, and the capacity to contest automated or platform-mediated decisions.
- Quality verification and pedagogical validation: AI-assisted OER should be reviewed for accuracy, bias, accessibility, curricular alignment, pedagogical coherence, and contextual appropriateness. Quality assurance should be transparent and auditable, especially when resources are generated, translated, or adapted through AI systems.
- Rights, provenance, and licensing: AI-OER workflows should document sources, prompts where relevant, AI assistance, human contributions, licences, derivative status, and attribution. This pillar responds directly to the challenge of authorship and legal uncertainty in synthetic and AI-assisted educational content.
- Metadata, interoperability, and discovery: Resources should include metadata that supports accessibility, licensing, provenance, subject classification, language, adaptation history, review status, and machine-actionable discovery. Metadata becomes a governance mechanism when AI systems participate in recommending, adapting, or sequencing resources.
- Accessibility, localisation, and sustainable monitoring: AI-OER integration should support multilingual adaptation, accessibility, low-resource contexts, inclusive design, and continuous evaluation. Monitoring should examine educational value, equity effects, platform dependency, and unintended consequences over time.

DISCUSSION

Responsible AI-OER integration requires more than the addition of generative AI tools to existing OER workflows; it requires a governance architecture capable of addressing how educational resources are produced, attributed, validated, circulated, and sustained under

algorithmic and platform-mediated conditions. [Table 1](#) supports this interpretation by showing that AI and OER frameworks remain only partially aligned: AI instruments tend to emphasise ethics, human-centred design, competencies, data protection, and policy readiness, whereas OER instruments foreground openness, access, licensing, reuse, repository infrastructures, quality assurance, and international cooperation. This finding is consistent with international guidance that treats AI ethics, competencies, open knowledge, and equitable access as central educational policy concerns, but it also reveals a limitation when these instruments are considered separately: AI guidance does not consistently conceptualise educational content as part of a knowledge commons, while OER guidance has not yet fully incorporated algorithmic mediation, adaptive systems, and generative content workflows ([OECD, 2015, 2019; UNESCO, 2011, 2019a, 2019b, 2021, 2024a, 2024b, 2024c](#)). Recent AI-OER works confirm the need for implementation models in the AI era, while extending this discussion through a stronger emphasis on institutional accountability, provenance, interoperability, quality assurance, and public-interest infrastructure ([Duan, 2026; Gillet et al., 2024; Tlili & Burgos, 2024; Tlili et al., 2026](#)). For practice and research, this implies that AI-OER convergence should be studied and implemented as a governance problem rather than as a matter of isolated tool adoption or content-production efficiency.

Meaningful human agency in AI-mediated OE cannot be reduced to the formal presence of a person in an automated workflow; it depends on whether educators, learners, librarians, instructional designers, and institutions have the authority, competence, time, and procedural support required to exercise informed judgement. [Table 2](#) supports this finding by showing that experts, informants, and workshop participants associated responsible AI-OER integration with human agency, openness beyond licensing, quality verification, collective governance, capacity-building, and gradual institutional transition. This result is consistent with critical perspectives that caution against treating generative AI as a neutral educational technology and with research showing that educators may work productively with AI while retaining pedagogical responsibility ([Bozkurt et al., 2024; van den Berg, 2024](#)). It also extends broader literature on AI in education by specifying that trust, explainability, teacher agency, and professional development cannot be separated from institutional conditions for review, accountability, and pedagogical validation ([Feldman-Maggor et al., 2025; Holmes et al., 2022; Nazaretsky et al., 2022](#)). The implication is that human agency should be designed into institutional workflows through role clarity, provenance procedures, quality criteria, professional learning, and decision-making authority, rather than invoked only as an abstract ethical principle.

Openness in AI-mediated educational environments must be understood as a socio-technical and institutional condition rather than as a licensing attribute alone. [Figure 1](#) supports this argument by presenting the OE-AI Framework as a seven-pillar architecture in which normative orientation, governance, pedagogy, quality, rights and provenance, metadata and interoperability, and accessibility and monitoring are treated as interdependent dimensions of responsible integration. This finding agrees with previous works on synthetic content, authorship, ownership, and transparent reporting in OE, but it also expands the discussion by connecting these concerns to repository practices, metadata schemas, institutional policies, authoring tools, and quality-review procedures ([Bozkurt, 2023, 2024](#)). It further frames educational resources as increasingly dynamic, adaptive, interactive, and platform-mediated rather than as stable content artefacts ([Agarwal & Aston, 2024; Al Abri et al., 2025; Ding, 2025; Li et al., 2023; Lim, 2024; Volkov, 2025](#)). This has practical consequences for the classical OER freedoms of retaining, reusing, revising, remixing, and redistributing. Each may be constrained or reconfigured by unclear provenance, platform terms, AI-generated intermediaries, incompatible licences, opaque training data, or insufficient disclosure. Future research should therefore examine how openness can become auditable, machine-actionable, pedagogically trustworthy, and sustainable within AI-mediated ecosystems.

Trust in AI-assisted OER depends not only on the apparent quality of educational content, but also on the visibility of the conditions under which that content is generated, reviewed, adapted, licensed, discovered, and circulated. The findings show that quality, credibility, and accountability emerged across the documentary analysis and stakeholder-informed evidence as recurrent conditions for responsible AI-OER convergence, particularly in relation to provenance, review status, licence compatibility, accessibility metadata, adaptation history, infrastructure dependency, and institutional accountability. This result emphasise trust, explanation, quality assurance, accessibility, and professional development in AI-enabled education, while also

extending these discussions by linking trust to the governance of OER and to the infrastructural conditions of their circulation (Holmes et al., 2022; Nazaretsky et al., 2022; Rampelt et al., 2025). Critical analyses of platformisation and political economy in educational technology, which warn that educational innovation may be shaped by cloud infrastructures, proprietary systems, data extraction, and market-oriented platform logics (De Andrade et al., 2023; Frohmann, 2023; Grimaldi et al., 2025; Mishra, 2023; Wang, 2020) help to identify a relevant trend from this finding. For practice, the OE-AI Framework can be used as a diagnostic tool for reviewing AI-assisted OER workflows, a planning tool for institutional policy, and a reflective tool for professional development; for research, it indicates that future evaluations should move beyond usability, learning gain, or efficiency to examine accountability, provenance, accessibility, licensing, educator agency, repository governance, infrastructure choice, and the distribution of responsibility across socio-technical systems.

CONCLUSION, IMPLICATIONS AND SUGGESTIONS

This article addressed the question of how generative AI and OER can be responsibly integrated in HE and LLL. The study found that responsible integration requires more than the use of AI to accelerate OER production. It requires: (a) alignment between AI ethics and OER governance; (b) institutional mechanisms for quality, rights, provenance, metadata, and accountability; (c) preservation of human agency and pedagogical responsibility; and (d) public-interest choices about infrastructures, accessibility, localisation, and sustainable monitoring. The OE-AI Framework synthesises these conditions into seven interdependent pillars that can support institutional decision-making.

The answer proposed by the study is that responsible integration requires alignment across seven interdependent areas: normative orientation and public value; collective governance and accountability; human agency in AI-assisted authoring; quality verification and pedagogical validation; rights, provenance, and licensing; metadata, interoperability, and discovery; and accessibility, localisation, and sustainable monitoring. These areas translate the evidence into an institutional architecture that can guide decision-making without assuming that all institutions begin from the same level of capacity or digital maturity.

The practical implication is that institutions should treat AI-OER integration as a governance and capacity-building agenda. Policies should define roles and responsibilities; repositories should incorporate provenance, metadata, review status, and accessibility information; educators should receive integrated training in AI and OER literacies; and procurement decisions should consider interoperability, data governance, and public value. The research implication is that AI-OER studies should move beyond isolated accounts of tool effectiveness and examine the institutional, legal, pedagogical, and infrastructural conditions under which openness can be maintained.

The study has limitations. It develops a framework through integrative analysis and stakeholder-informed co-creation, but it does not test the framework longitudinally through institutional implementation. The stakeholder component provided situated expert and practitioner perspectives, but it should not be interpreted as representative of all educational contexts. The documentary corpus privileged international policy and recent literature relevant to HE and LLL, and further work is needed in non-dominant linguistic contexts, Global South settings, accessibility domains, and non-formal education. Future research will develop the OE-AI Framework across policy, methodology and technical toolkits to apply it in repositories, courses, institutional policies, and cross-national partnerships to examine how its pillars operate in practice and how they can be adapted to local governance realities.

DATA ACCESSIBILITY STATEMENT

The datasets generated and/or analysed during the current study are available in the <https://repositorio.tec.mx> repository upon request.

SUSTAINABLE DEVELOPMENT GOALS (SDGs)

This study is linked to the following SDG(s): Quality education (SDG 4).

The additional file for this article can be found as follows:

- **Appendices.** Appendix A to C. DOI: <https://doi.org/10.55982/openpraxis.18.4.1267.s1>

ETHICS AND CONSENT

Ethical approval was obtained for the work described in this article (P-IFE-202506-002).

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COMPETING INTERESTS

The authors have no competing interests to declare.

AUTHOR CONTRIBUTIONS (CRediT)

Virginia Rodés: Conceptualization, methodology, investigation, formal analysis, data curation, visualization, writing (original draft preparation, writing) review and editing, project administration, and funding acquisition. Javiera Atenas: Methodology, formal analysis, investigation, data curation, writing (original draft preparation, and writing), review and editing. All authors have read and agreed to the published version of the manuscript.

AUTHOR NOTES

Based on Academic Integrity and Transparency in AI-assisted Research and Specification Framework (Bozkurt, 2024), the authors acknowledge the use of OpenAI's ChatGPT (GPT-5.5 Thinking, May 2026) to assist with writing, editing, and language refinement of the manuscript. All AI-assisted content was critically reviewed, revised, and validated by the human authors to ensure academic rigor, accuracy, and ethical compliance. The authors assessed and addressed potential biases or inaccuracies in the AI-assisted outputs. The final content, interpretations, conclusions, and assertions are the sole responsibility of the human authors.

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