

IMMERSIVE PEDAGOGY AND EMBODIED DATA: IP AND PRIVACY RISKS IN EUROPEAN EDUCATIONAL METAVERSES

Alberto Nico¹, Flavio Manganello², Giannangelo Boccuzzi³,
Giancarlo Masi⁴, Rosa Rondinelli⁵, & Martina Ragusa²

¹*Department of Law, University of Bari (Italy)*

²*Institute for Educational Technology, National Research Council (Italy)*

³*Institute for Educational Technology, National Research Council – University of Bologna (Italy)*

⁴*Institute for Educational Technology, National Research Council – University of Modena and Reggio Emilia (Italy)*

⁵*Department of Earth and Geo-Environmental Sciences, University of Bari (Italy)*

Abstract

Immersive and metaverse-like learning environments are increasingly discussed as emerging infrastructures for higher education, particularly in relation to virtual laboratories, simulations, collaborative learning, and avatar-mediated interaction. Yet their pedagogical potential is accompanied by a complex legal and governance landscape. On the one hand, these environments operate as persistent spaces of content production, modification, and circulation, where students, teachers, institutions, and platform providers may all become implicated in questions of authorship, co-authorship, licensing, attribution, portability, and downstream reuse. On the other hand, immersive systems intensify privacy concerns because they enable the collection of dense streams of behavioural and potentially biometric data, including gaze, posture, voice, gesture, and interaction traces, from which highly sensitive inferences may be drawn. This paper argues that, in European educational metaverses, intellectual property and privacy should not be treated as distinct regulatory domains, but as interdependent dimensions of the same socio-technical infrastructure. To develop this argument, the paper proposes an analytical matrix structured around four stages of immersive learning activity: creation and remix of artefacts, platform hosting and moderation, recording and reuse for teaching and assessment, and data extraction for analytics. The framework is then applied to two scenarios: a virtual laboratory based on collaborative 3D creation and an avatar-mediated learning environment with monitoring functions. The analysis shows that the same contractual and technical affordances that organise authorship and reuse also facilitate persistent tracking, data retention, and secondary processing. The paper concludes that European educational institutions should assess immersive learning environments not only as pedagogical tools, but also as infrastructures that simultaneously distribute creative control and intensify data capture.

Keywords: *Educational metaverse, intellectual property, data protection, copyright, XR privacy.*

1. Introduction

Recent scholarship on the educational metaverse has consistently emphasized the pedagogical promise of immersive environments, particularly their capacity to support presence, embodiment, collaboration, simulation, and avatar-mediated participation in learning activities (Hwang & Chien, 2022; Zhang et al., 2022; Onu et al., 2024). These studies describe immersive educational environments as emerging ecosystems in which the boundaries between physical and virtual learning spaces become increasingly porous and where experiential, interactive, and persistent forms of participation may substantially expand the repertoire of higher education pedagogy (Hwang & Chien, 2022; Zhang et al., 2022). At the policy level, the European Commission has likewise framed virtual worlds and Web 4.0 as a strategic domain that should develop within an open, secure, trustworthy, fair, and inclusive digital environment (European Commission, 2023).

However, a purely innovation-oriented account of educational metaverses is insufficient. Immersive learning environments are not only pedagogical spaces; they are also persistent infrastructures for producing, modifying, storing, recording, and circulating digital artefacts. In this respect, they can be understood as “factories of works,” since they continuously generate potentially copyright-relevant outputs such as avatars, 3D objects, virtual scenes, recordings, and composite environments. The abstract already identified this duality as central to the paper’s contribution. At the same time, recent empirical work shows that privacy, digital identity, informed consent, fairness, and ethical trust are already perceived by students as significant conditions for the acceptance of metaverse-based classrooms (Al-kfairy et al., 2025).

This paper therefore argues that intellectual property and privacy are structurally entangled in European educational metaverses. The central claim is that the same platform architectures, contractual terms, and technical affordances that govern ownership, attribution, reuse, and portability also govern the capture, retention, processing, and inferential use of embodied learner data. For that reason, immersive learning should be analysed not as a neutral educational innovation onto which legal issues are later added, but as an environment in which content governance and data governance are co-produced from the outset. That argument is developed here through an analytical matrix already anticipated in the abstract.

2. Intellectual property and privacy as interlocking governance problems heading

The first dimension concerns intellectual property. In immersive educational settings, creative output is rarely discrete, stable, or attributable to a single moment of authorship. Instead, artefacts are commonly co-produced, iteratively modified, embedded within platform environments, and subsequently reused for teaching, assessment, demonstration, or institutional communication. This makes authorship and co-authorship especially difficult to determine, while also foregrounding questions concerning the scope of licences, moral-rights sensitivities, institutional reuse, and platform lock-in. Legal scholarship on the metaverse has repeatedly underlined that intellectual property disputes in these environments are shaped not only by substantive copyright doctrine but also by contractual infrastructures, avatar-related legal ambiguities, and the practical redistribution of control through platform governance (Cheong, 2022; Vig, 2022). In the educational context, the key issue is therefore not simply who created a virtual artefact, but who may store it, alter it, display it, relicense it, or prevent its export to another environment.

The second dimension concerns privacy and data protection. A growing body of XR scholarship shows that immersive environments are capable of collecting highly granular streams of non-verbal and behavioural information, including movement patterns, spatial relations, gaze trajectories, body posture, and interaction habits (Giaretta, 2025; Hine et al., 2024). Survey work on VR privacy and security stresses that these systems collect precisely the forms of non-verbal information that can reveal user preferences, behavioural patterns, and performance traits (Giaretta, 2025). More importantly, behavioural-biometrics research has shown that identification in VR can be inferred from body motion and relational movement patterns, while subsequent work has confirmed the feasibility of identifying users from behavioural traces even under conditions of normalization (Pfeuffer et al., 2019; Liebers et al., 2021). Recent work in Social VR has gone further, showing that eye-gaze behaviour alone can identify users with very high accuracy (Rubo & Son, 2025). The legal significance of these findings is substantial, because they suggest that data often presented as merely functional or non-identifiable may, in practice, support re-identification, profiling, or sensitive inference.

In the European legal framework, this concern is sharpened by the GDPR. The Regulation defines biometric data as personal data resulting from specific technical processing relating to physical, physiological, or behavioural characteristics that allow or confirm the unique identification of a natural person, and it treats biometric data used for uniquely identifying a person as a special category of data (European Parliament and Council of the European Union, 2016, art. 4(14), art. 9). The GDPR also requires a data protection impact assessment where new technologies are likely to generate high risks, including where personal data are processed for systematic and extensive evaluation of personal aspects based on profiling (European Parliament and Council of the European Union, 2016, art. 35). This matters for educational metaverses because recording, monitoring, learning analytics, and avatar-mediated assessment may all combine to produce forms of systematic observation that exceed what is ordinarily associated with standard e-learning environments. At the same time, the DSM Directive confirms that digital teaching uses are legally significant within the EU copyright framework and that contractual provisions contrary to the teaching exception are unenforceable, thereby making the relation between copyright rules and platform contracts especially important for educational institutions (European Parliament and Council of the European Union, 2019, art. 5, art. 7).

3. Analytical framework and method

To capture this interdependence, the paper develops an analytical matrix structured around four stages in the lifecycle of immersive learning activities: creation and remix of artefacts; platform hosting and moderation; recording and reuse for teaching and assessment; and data extraction for analytics. For each stage, the framework examines the relevant IP nodes—authorship, co-authorship, license scope, attribution, moral-rights concerns, portability, and downstream reuse—alongside the relevant privacy nodes—data categories, telemetry, biometric or quasi-biometric potential, inference pathways, retention, secondary use, and controller–processor allocation. The purpose of the matrix is not merely classificatory. Rather, it is designed to expose the points at which content governance and data governance become inseparable in practice.

Methodologically, the paper combines doctrinal legal analysis with a socio-technical reading of immersive platforms. The doctrinal layer relies primarily on EU copyright and data-protection sources, while the socio-technical layer is informed by recent scientific literature on immersive learning, XR privacy, behavioural biometrics, and metaverse ethics (Hwang & Chien, 2022; Zhang et al., 2022; Giaretta, 2025; Hine et al., 2024). This combination is important because many of the most significant risks in immersive education do not arise from formal legal categories alone, but from the way in which platform design, monitoring tools, default settings, retention systems, and terms of service operationalise those categories. The framework is then tested through scenario-based application to two use cases already identified in the abstract: a virtual laboratory involving collaborative 3D creation and an avatar-mediated learning environment incorporating monitoring features.

4. Scenario analysis

The first scenario concerns a virtual laboratory in which students collaboratively create and manipulate 3D artefacts. From a pedagogical perspective, such a setting exemplifies the educational value of the metaverse: it supports experimentation, shared construction, situated problem-solving, and persistent access to co-created resources (Hwang & Chien, 2022; Onu et al., 2024). Yet the same scenario immediately raises legal questions. If students jointly build virtual objects, textures, or scenes, it may be unclear whether the resulting artefacts should be treated as individual or collective works, how attribution should operate, whether institutional reuse requires further authorization, and how far platform terms extend over stored or exported content (Cheong, 2022; Vig, 2022). Simultaneously, the platform may log fine-grained interaction data about who manipulated which object, when, for how long, with what degree of success, and in what sequence. In other words, the infrastructure that preserves and organises collaborative authorship also preserves and organises behavioural visibility.

The second scenario concerns an avatar-mediated learning and assessment environment with monitoring functions. Here the legal entanglement becomes even clearer. Avatar-based participation may generate a range of potentially protectable artefacts, including customized avatars, recorded performances, virtual presentations, shared spatial arrangements, and session captures (Cheong, 2022). At the same time, assessment features may rely on voice data, gaze direction, posture, gesture, timing, and other interaction metrics that can become proxies for attention, credibility, engagement, or competence. Recent research on user identification in immersive environments underscores how easily seemingly routine behavioural data can become identifying or inferentially rich (Pfeuffer et al., 2019; Liebers et al., 2021; Rubo & Son, 2025). In educational contexts, this is especially problematic because students are rarely situated as fully autonomous market actors; rather, they participate within an institutional relationship marked by dependency, evaluation, and limited bargaining power. The result is that monitoring functions may simultaneously expand institutional control over both educational content and embodied learner data.

5. Discussion and conclusions

The analysis confirms the paper's core claim: in European educational metaverses, intellectual property and privacy are not merely adjacent concerns but mutually reinforcing dimensions of the same governance problem. What appears, from one angle, as a question of authorship, licensing, or reuse often appears, from another, as a question of telemetry, retention, profiling, or secondary processing. The literature on immersive education already points to privacy, ethics, and trust as central conditions for sustainable adoption (Al-kfairy et al., 2025), while XR scholarship increasingly demonstrates that movement, gaze, and other embodied signals can become identifying and inferentially sensitive (Giaretta, 2025; Hine et al., 2024; Rubo & Son, 2025). Legal analysis of metaverse environments, in turn, shows that rights allocation and platform control are inseparable from broader questions of responsibility and user protection (Cheong, 2022; Vig, 2022). Taken together, these strands of scholarship support the conclusion

that the educational metaverse should be treated as a legally dense infrastructure rather than as a merely innovative teaching tool.

For European educational institutions, the practical implication is straightforward. Decisions to adopt immersive platforms should be preceded by close scrutiny of platform terms, clear internal governance over authorship and reuse, restrictions on recording and secondary processing, and rigorous DPIA-oriented assessment wherever behavioural monitoring or analytics are involved (European Parliament and Council of the European Union, 2016, art. 35; European Commission, 2023). The most important lesson is therefore institutional rather than technological: immersive learning environments redistribute rights and responsibilities across students, teachers, institutions, and providers, and that redistribution must be governed explicitly. A European approach to educational metaverses should consequently combine pedagogical ambition with legal caution, ensuring that innovation does not normalize opaque ownership structures or excessive capture of embodied learner data.

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