Immersive Storytelling for Co-creation in XR: A Four-Dimension Framework

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Abstract. Extended Reality (XR) is increasingly adopted for collaborative work, yet immersive storytelling and co-creation are often examined in isolation. This paper presents a conceptual review of XR systems where narrative structures and multi-user creation intersect. It introduces a four-dimensional framework encompassing *Platform Affordances*, *Narrative Control*, *Participant Agency*, and *Adaptive Mediation*. We position narrative not as an added layer but as a mechanism for organising collaboration. In this paper, we (i) synthesise how presence, interactivity, and authorship are operationalised across existing systems; (ii) define indicators for classifying XR co-creative experiences along the four dimensions; and (iii) outline directions for empirical validation, including comparative studies of control–agency trade-offs. We illustrate the framework by mapping representative platforms and sketching hybrid designs that balance authored coherence with emergent improvisation. Ethical considerations in AI-supported mediation, such as authorship, transparency, and accessibility, are also discussed. The framework offers a structure for comparative research and the design of XR systems where storytelling enables co-creative practice.

Keywords: Extended Reality (XR) · Immersive storytelling · Co-creation · Narrative control · Participant agency · Adaptive mediation

1 Introduction

Immersive extended reality (XR) technologies, encompassing virtual reality (VR), augmented reality (AR), and mixed reality (MR), are reshaping how narratives are constructed, experienced, and shared. By blending physical and digital domains, XR creates participatory environments that support dynamic interaction, spatial exploration, and co-presence through avatars and sensory feedback [43,48,49]. These affordances position XR not only as a medium of delivery but also as a co-creative space where users become collaborators in real-time, multisensory storytelling.

The interdisciplinary impact of XR is well documented. In design and architecture, XR enhances early ideation through multi-user interaction and real-time

manipulation of digital prototypes [5,15,23]. In healthcare, XR supports co-creation via patient-centred simulations and collaborative training environments [42]. In education, immersive virtual environments (IVEs) promote participatory learning and collaborative problem-solving, often yielding greater engagement than traditional methods [19,50]. Entertainment contexts push XR toward adaptive and participatory formats, blending live performance with algorithmic storytelling and spatial computing [1,12].

Yet the integration of co-creative affordances with immersive narrative structures remains fragmented. Much of the literature isolates technical implementation from narrative design or treats user experience without considering collaborative authorship. As a result, design practices that foreground narrative agency, collaboration, and platform affordance in unison are still underdeveloped.

This paper addresses this gap by presenting a conceptual literature review and introducing a speculative framework organised around four intersecting dimensions: *Platform Affordances*, *Narrative Control*, *Participant Agency*, and *Adaptive Mediation*. Narrative is treated here not as an additional layer but as a mechanism that organises collaboration.

This paper makes three contributions:

1. A synthesis of research connecting immersive storytelling and co-creation in XR.
2. A four-dimensional framework with indicators for analysing XR systems: platform affordances, narrative control, participant agency, and adaptive mediation.
3. An outline of future evaluation pathways, including comparative studies of control–agency trade-offs and the role of adaptive mediation.

Rather than proposing a fixed model, the framework is offered as a structure for critically navigating and guiding the design of XR systems where storytelling becomes collaborative world-making.

2   Related Work

Immersive storytelling and co-creation have been widely studied in parallel, yet their integration within XR environments remains underexplored. Immersive storytelling highlights how presence, interactivity, and agency shape engagement in narrative-driven IVEs, while co-creative practices emphasise processes and affordances that enable distributed authorship. XR offers distinctive affordances of embodiment and shared immersion that make this convergence especially promising, but recent work also identifies technical, social, and platform constraints. To prepare the ground for our framework, we review the foundations of immersive storytelling, co-creative practices, and opportunities and challenges in XR-based collaboration.

2.1   Foundations of Immersive Storytelling

Immersive storytelling leverages XR technologies to support interactive narrative experiences characterised by presence, embodiment, and user agency [34,38]. Unlike linear formats, IVEs invite participants to shape outcomes through movement, object interaction, and decision-making [25,31]. Presence (the sensation of "being there") arises from multimodal immersion [30,35]; interactivity allows participants to respond to and influence events [16,25]; and agency grants them meaningful choices [10,46].

Different XR modalities support distinct narrative affordances. VR offers fully immersive worlds (e.g., *Half-Life: Alyx* [41]); AR layers narrative onto real space (e.g., *Pokémon Go* [27]); and MR blends digital and physical elements for shared embodiment (e.g., *Pillow* [29]). These modalities show how narrative control and participant agency are configured through platform affordances, a link we develop in our framework.

2.2   Co-creative Practices and Collaboration

Co-creation describes processes in which stakeholders collectively shape ideas or systems, emphasising shared authorship and integrating multiple perspectives [6,14]. Rooted in participatory design movements of the 1980s, co-creation has become a methodology for innovation across healthcare, urban planning, and interactive media [18,22]. A key distinction is between expert design and diffuse design, highlighting the value of engaging end users during early ideation or the "fuzzy front end" [32]. This positions the designer as facilitator within distributed networks [21].

Digital platforms such as *Tele-Board* [45] and *Figma* [7] extend these practices into synchronous, distributed collaboration. XR environments add further affordances: spatial co-presence, gestural interaction, and shared prototyping in 3D spaces [5,11]. These qualities speak directly to participant agency and platform affordances in co-creative contexts.

2.3   Opportunities and Challenges in XR Co-creation

Multi-user XR platforms such as *Spatial* [37], *The Wild* [39], and *CollaboVR* [3] demonstrate persistent environments where dispersed participants co-design and iterate on content [8,33]. These affordances strengthen spatial cognition and contextual anchoring, but also introduce challenges. The absence of subtle non-verbal cues can inhibit rapport and trust, requiring facilitation and scaffolding [4,28,40,47]. Technical constraints such as latency and tracking errors reduce fluency, while sustaining co-presence remains a core design challenge [2].

Another issue is platform instability. Services have been rebranded, discontinued, or folded into other ecosystems (e.g., AltspaceVR, Mozilla Hubs, Microsoft Mesh), raising concerns about dependency, asset preservation, and long-term collaboration. Such dynamics highlight the need for adaptive mediation and sustainable design choices.

Together, these studies underline the opportunities and tensions of XR co-creation, pointing to the necessity of conceptual models that integrate platform affordances, narrative control, participant agency, and adaptive mediation.

3   Research Gaps and Questions

Although immersive storytelling and co-creative practices are both well established, research often treats them separately. This separation fragments design approaches, leaving narrative techniques and collaborative affordances only loosely aligned. Our review highlights our four interrelated gaps, each corresponding to one of the dimensions we later develop in our framework.

These gaps motivate our overarching research question: **What mechanisms of immersive storytelling can foster co-creative engagement in multi-user XR environments?** To operationalise this inquiry, we explore four guiding sub-questions:

– **RQ1**: How can XR platforms integrate spatial embodiment, multi-user interaction, and narrative continuity to support both immersion and collaboration?
– **RQ2**: How can layered forms of agency be designed to accommodate diverse participant roles, expertise levels, and cultural contexts?
– **RQ3**: How can XR systems balance scripted narratives with emergent interactions to support both coherence and improvisation?
– **RQ4**: How can adaptive systems mediate storytelling and collaboration in ways that ensure coherence, fairness, and inclusivity while preserving participant autonomy?

4   Speculative Framework

Building on these gaps, we propose a framework for immersive co-creation in XR structured around four intersecting dimensions (Fig. 1): *Platform Affordances*, *Narrative Control*, *Participant Agency*, and *Adaptive Mediation*. Each dimension captures a different axis of design choice. Together, they provide a structure for classifying existing systems, identifying gaps, and guiding new prototypes. In addition to the conceptual map shown in Fig. 1, Table 1 lists indicative features for each dimension. These indicators are not exhaustive but provide a practical guide for researchers and designers to classify XR systems and compare configurations across studies.

4.1   Platform Affordances

Platform affordances form the foundation, shaping the modalities through which users interact and collaborate. Following Technology Affordance and Constraint Theory (TACT) [20], they are relational possibilities emerging from the interplay of system features and user practices.
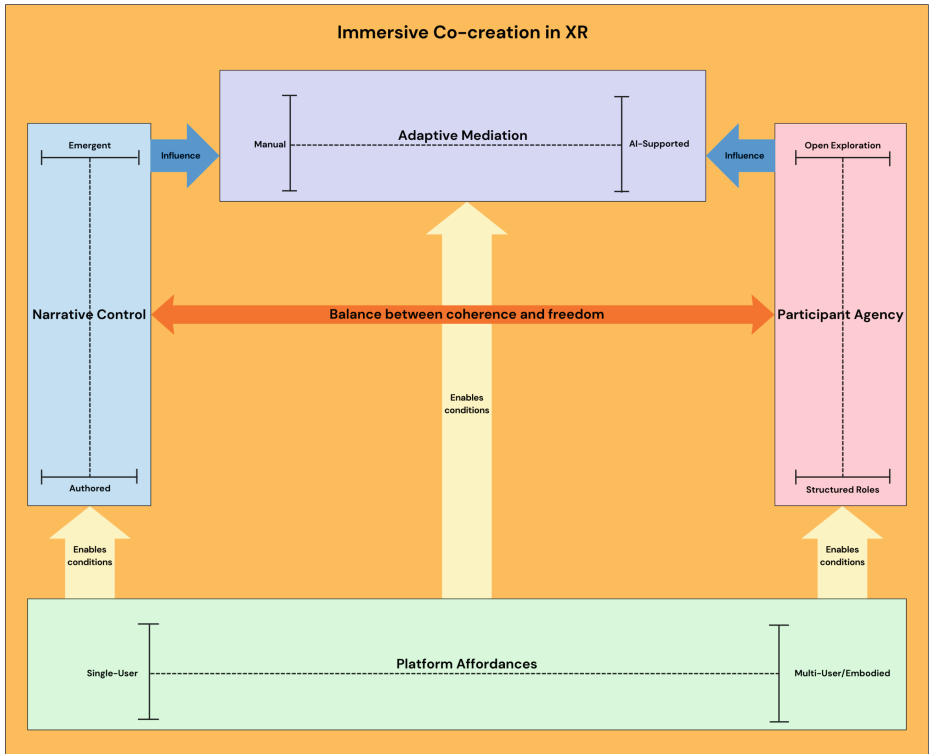
Fig. 1. Framework for immersive co-creation in XR. The four axes highlight trade-offs that shape design and experience.

For instance, single-user tools such as *Open Brush* [13] privilege individual expressivity, while multi-user platforms such as *Gravity Sketch* [9] foreground co-presence and shared spatial construction. Each mode affords creativity but also imposes constraints; individual tools can limit dialogue, while collaborative ones introduce coordination overhead. Recent updates, such as the new multiplayer version of *Open Brush*, illustrate how affordances can shift as platforms evolve.

Designing for flexible transitions (e.g., moving between solo creation and group improvisation) broadens inclusivity and sustains engagement. In the framework, platform affordances thus underpin the other three dimensions by structuring what kinds of narrative control, agency, and mediation are possible.

4.2   Narrative Control

Narrative control spans a spectrum from authored to emergent forms. Authored experiences, such as *Detroit: Become Human* [44] or creation tools like *Quill by Smoothstep* [36], offer coherence and polish but limit improvisation and often privilege individual authorship. Emergent narratives, common in social VR,

unfold through participant interaction or system behaviour, maximising openness but risking fragmentation. The design challenge lies in hybrid approaches that provide enough scaffolding to sustain shared meaning while leaving room for distributed agency. Within our framework, narrative control highlights how story structure organises collaboration and coherence.

4.3   Participant Agency

Participant agency refers to the degree of freedom users have in shaping both process and outcome. Structured roles (e.g., assigned characters or goals in *Half-Life: Alyx*) constrain choice but provide coherence and reduce friction. Open exploration, common in social VR, allows self-defined avatars, narratives, and goals, fostering improvisation but sometimes leading to imbalance or incoherence. Platforms like *StoryBank* [21] show how inclusive structures can support both personal expression and collective ownership. Effective systems often layer participation, providing guided pathways for novices and open-ended tools for experts. In the framework, agency represents the human-centred driver of co-creative engagement.

4.4   Adaptive Mediation

Adaptive mediation describes how systems guide or adjust the storytelling process, ranging from manual facilitation to AI-supported co-authoring. Most XR platforms still rely on manual mediation through user actions or static scripts, but AI introduces more dynamic roles. Training systems such as *Mondly VR* [24] and *Mursion* [26] use AI-driven characters to guide interaction and pace collaborative flow, while narrative generators like *AI Dungeon* [17] position AI as a co-author. We distinguish two roles: facilitator (structuring flow, prompts, and coherence) and collaborator (actively co-creating content). The challenge is balancing low-level feedback with higher-level interventions so that AI augments rather than replaces human authorship. In the framework, adaptive mediation captures this shifting role of the system in sustaining collaboration.

4.5   Interactions Across Dimensions

The four dimensions are interdependent. *Platform affordances* set the conditions for interaction, shaping what kinds of *narrative control* and *participant agency* are possible. *Adaptive mediation* then modulates these dynamics by pacing interactions, redistributing authorship, or scaffolding collaboration. Although overlaps exist, for example, agency and narrative control both address how participants shape outcomes, treating them as distinct helps clarify design trade-offs. Adaptive mediation is kept separate to capture the system's active role in facilitating, guiding, or co-authoring, rather than folding it into either user agency or story control.

A speculative scenario can illustrate the interplay (Table 1): participants build narrative spaces through gestures, voice, and object manipulation; narrative arcs provide partial scaffolding but allow emergent contributions; roles can be fixed or fluid; and AI agents act both as facilitators (offering prompts, balancing contributions) and collaborators (adding dialogue or environmental elements). In this way, platform features, narrative structures, participant roles, and mediation mechanisms combine to foster empathy, reflection, and co-creative engagement. The framework, therefore, supports both research and design by offering a lens to classify XR systems, identify gaps, and explore how different configurations of the four dimensions shape immersive co-creation.

Table 1. Indicative features for classifying XR co-creative systems along the four dimensions of the framework.

Platform affordances	Multi-user synchrony; persistence of shared artefacts; avatar/body tracking; cross-device compatibility; support for transitions between solo and group creation
Narrative control	Presence of authored arcs or goals; branching or modular structures; diegetic prompts or constraints; facilitator/director roles; mechanisms for sustaining coherence
Participant agency	Role assignment and flexibility; editing and contribution rights; turn-taking or coordination mechanics; balance of contributions; pathways for novices vs. experts
Adaptive mediation	Manual facilitation vs. AI guidance; adaptive pacing or difficulty; NPC scaffolding; AI co-authoring of dialogue or assets; transparency of system interventions

Beyond speculative scenarios, the framework can also be applied to existing XR systems. Figure 2 maps representative platforms along the four dimensions as a general exemplification, illustrating how different configurations of affordances, control, agency, and mediation manifest in practice. The additional outcome column groups platforms into three broad categories: artefact-oriented outcomes (e.g., 3D models, paintings, or animations), experience-oriented outcomes (e.g., emergent social play, narrative journeys, or meditative sessions), and training-oriented outcomes (e.g., role-played conversation practice). This comparative view highlights how some platforms privilege open-ended creativity (e.g., *Open Brush*, *VRChat*), while others introduce structured collaboration or AI-supported facilitation (e.g., *Mondly VR*, *Mursion*).

4.6 Discussion of Research Questions

The framework provides a conceptual response to the four guiding questions. For RQ1, *Platform Affordances* underpin the integration of spatial embodiment, multi-user interaction, and narrative continuity. RQ2 is addressed through the layering of *Participant Agency*, which enables both structured and open-ended roles. RQ3 is reflected in hybrid models of *Narrative Control* that balance authored scaffolds with emergent improvisation. Finally, RQ4 is considered

Case	Platform Affordances	Narrative Control	Participant Agency	Adaptive Mediation	Typical Outcome
Tilt Brush	Single-user (VR)	User-authored (painting)	Open exploration	Manual	Artefact-oriented
Open Brush	Single-user / Multi-user (VR)	User-authored (painting)	Open exploration	Manual	Artefact-oriented
Quill by Smoothstep	Single-user (VR)	User-authored (animation arcs)	Open exploration	Manual	Artefact-oriented
Gravity Sketch	Multi-user (VR)	User-authored (3D modeling)	Open exploration	Hybrid (manual + AI facilitator for image-to-3D model)	Artefact-oriented
VRChat	Multi-user (VR)	Emergent (participant-driven worlds)	Open exploration	Manual	Experience-oriented
Rec Room	Multi-user (VR)	Emergent (mini-games, social play)	Open exploration	Manual	Experience-oriented
CollaboVR, The Wild, Spatial	Multi-user (VR)	Emergent (collaboration)	Open exploration	Manual	Artefact-oriented
Mondly VR	Single-user (VR)	Designer-authored	Structured roles	AI-supported (facilitator: guides flow and provides real-time feedback)	Training-oriented
Mursion	Multi-user (MR)	Designer-authored	Structured roles	AI-supported (facilitator: guides flow and provides real-time feedback)	Training-oriented
Pokémon Go	Single-user (AR)	Hybrid (designer-authored quests + emergent exploration)	Open exploration	Manual	Experience-oriented
Half-Life: Alyx	Single-user (VR)	Designer-authored	Structured roles (player as protagonist)	Manual	Experience-oriented
Pillow	Single-user / Multi-user (MR)	Hybrid (designer-authored dreams + emergent voice sharing and meditative)	Open exploration	Manual	Experience-oriented

Fig. 2. Representative XR platforms mapped across the four framework dimensions.

through *Adaptive Mediation*, where AI functions as a facilitator or collaborator to support inclusivity while preserving autonomy. These responses provide a conceptual foundation; further research is needed to investigate and validate them in empirical settings.

5   Conclusion and Future Work

This paper has proposed a framework for integrating immersive storytelling and co-creation in XR, structured around four intersecting dimensions: *Platform Affordances*, *Narrative Control*, *Participant Agency*, and *Adaptive Mediation*. Rather than prescribing fixed models, the framework offers a lens for analysing systems, identifying gaps, and guiding design choices where narrative operates as a mechanism for collaboration. The framework makes three contributions: (i) synthesising prior work at the intersection of storytelling and co-creation in XR; (ii) defining dimensions and indicative indicators that enable classification of systems; and (iii) outlining directions for evaluation, including comparative studies of control–agency trade-offs and the role of adaptive mediation.

Future work will operationalise these dimensions through empirical studies and prototype development, with several speculative directions linked to the guiding questions. For RQ1 (*Platform Affordances*), engagement and collaboration can be compared between single-user and multi-user prototypes developed around the same narrative setting. Such studies could measure how synchrony, shared artefact persistence, and embodied interaction influence presence, mutual awareness, and sustained engagement. For RQ2 (*Participant Agency*), experiments may manipulate role assignment and contribution rights to investigate effects on engagement and equity. By placing participants in different co-creative roles with varying authority and responsibility, it becomes possible to examine how asymmetries in agency shape collaboration, while also fostering empathy and perspective-taking. For RQ3 (*Narrative Control*), controlled comparisons could contrast a neutral baseline with prototypes enriched by thematic narrative structures, assessing how framing supports coherence, creativity, and participant investment. This would help clarify trade-offs between narrative control and openness in shaping co-creative outcomes. For RQ4 (*Adaptive Mediation*), exploratory trials may deploy AI as facilitators or collaborators to examine how mediation mechanisms influence inclusivity and autonomy. Possible scenarios include AI agents that guide pacing, redistribute contributions, or co-author dialogue and environmental elements. Evaluating user perceptions of transparency, authorship, and trust will be essential for understanding how adaptive mediation can enhance rather than diminish collaborative agency.

Ethical considerations remain central: questions of authorship, transparency, accessibility, and sustainability are critical when adaptive mediation – particularly AI-supported systems – shapes collaborative practice. By treating co-creation as both a narrative and socio-technical process, XR can support new forms of shared meaning-making, enabling designers, researchers, and communities to build immersive experiences that are inclusive, resilient, and creatively generative.

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