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Spatial User Experience in VR Narrative Systems: A Taxonomy from Scoping Review

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This study aims to develop a taxonomy of space-related user experiences in virtual reality narrative (VRN) environments. While VR research increasingly emphasizes immersion and interaction, space is seldom conceptualized as an active experiential medium. Our taxonomy addresses this gap. Adopting Nickerson's taxonomy development method, this research employs a scoping review following the PRISMA-ScR framework to identify and synthesize 85 relevant studies. Through six iterative cycles combining empirical-to-conceptual and conceptual-to-empirical strategies, we developed a taxonomy of seven dimensions and fifteen characteristics, clarifying how spatial design influences embodied, emotional, and cognitive aspects of narrative experience. It addresses key theoretical gaps by clarifying the diversity of space-related experiences and identifying underrepresented design elements such as narrative comprehension, memory recall, and audience-specific engagement. The taxonomy is intended to support researchers and designers to enhance the understanding and design of VR narrative systems through a spatial lens.

virtual reality, virtual reality narrative, narrative environment, user experience, taxonomy, spatial experience

1. INTRODUCTION

In Virtual Reality Narrative (VRN) systems, virtual spaces serve not only as containers for visual storytelling but can act as narrative media themselves, enhancing the embodied experience that supports user engagement (Austin 2020; Dooley 2024b). Despite the increasing use of VR in entertainment, education, therapy, and cultural heritage contexts (Irshad and Perkis 2020; Calvert and Hume 2022; Hajahmadi et al. 2024), spatial environments are often treated as background mostly embedding narrative elements Austin (2020), rather than actively being used as experiential and meaning-making components of narrative systems (Bucher 2017).

Existing research tends to emphasize the affective, interactive, or technological dimensions of user experience (Hameed et al. 2024). However, the aforementioned studies have drawn attention to the influence of treating VR narrative systems and virtual spatial environments as an integrated whole on user experiences (Ryan 2015; Dooley 2024b).

This study aims to develop a taxonomy of space-related user experiences in VR narratives,this paper addresses two research questions:

- **RQ1:** How can space-related user experiences in VR narrative systems be identified and systematically classified into a taxonomy to support the understanding of spatial narrative functions?
- **RQ2:** To what extent do the dimensions identified in the taxonomy explain how different types of spatial narrative systems shape distinct dimensions of user experience in VR?

Prior research has proposed various taxonomies of VR user experience (Hameed et al. 2024). This study contributes by consolidating concepts from spatial presence, embodiment, and spatial cognition literature (Slater and Wilbur 1997; Vallance and Towndrow 2022) into a taxonomy to clarify the experiential role of space in VR narratives and support the design of immersive narrative systems.

2. METHODOLOGY AND RESULTS

Step 1: Meta-characteristic: *space-related user experiences in VR narratives*.

Step 2: Ending conditions: The recommendations of Nickerson et al. (2013); Hevner et al. (2004) for the development of the taxonomy were met: (1) completeness, (2) coherence, and (3) explanatory power.

2.1. Iteration 1:

Step 3: We began with an empirical-to-conceptual strategy, using findings from prior VR narrative research to extract initial features.

Step 4e: To identify a representative subset of objects and extract recurring features, we conducted a scoping review following PRISMA-ScR guidelines (Tricco et al. 2018) to set up the subset of objects for the taxonomy. We select the following convenience sample of VR narrative systems from the scoping review.

Structured Narrative: A narrative system with a fixed structure that guides users through linear or branching story paths Murray (2017); **Perceptive Narrative**: A narrative conveyed primarily through sensory immersion and spatial design Austin (2020); **Cocreative Narrative**: A narrative shaped by user actions, decisions, and embodied participation Echeverri and Wei (2025).

The scoping review followed the PRISMA-ScR framework (Tricco et al. 2018) (see APPENDIX A 2). Four academic databases (ACM Digital Library, IEEE Xplore, AIS eLibrary, and Emerald Insight) were searched using terms “VR narrative experience”, “VR space storytelling”, and “immersive spatial experience”. Studies were included if they: (1) involved a VR environment, (2) contained a narrative component, and (3) addressed user experience in relation to space or immersion. Exclusion criteria includes not research article, not related to VR/ narrative/ user experience, lack focus on space-related experience/ user-centred perspective, and lack of methodological rigor or empirical grounding.

Step 5e: We identified four recurring user experience features: **Sense of Embodiment**, **Sense of Space**, **Spatial Presence**, and **Presence** (de Villiers Bosman et al. 2025; Kuksa and Childs 2014; Hartmann et al. 2015; Berkman and Akan 2019).

Step 6e: These were grouped into two conceptual dimensions—*Sensation* and *Location*—forming the initial taxonomy structure: **Taxonomy1 = {Sensation (Embodiment, Presence), Location (Sense of Space, Spatial Presence)}**

Step 7: Additional iterations were deemed necessary to expand and refine the taxonomy.

2.2. Iteration 2:

Step 3: We decide to use the empirical-to-conceptual approach again because we have identified additional VR narrative systems from previous research in the VR narrative area.

Step 4e: We select the following sample of additional VR narrative systems from the literature Dooley (2024b) and Ryan (2015): **Environmental Storytelling**: A narrative system in which space, objects, and atmosphere are used to convey story elements Dooley (2024a); **Social Narrative**: A narrative system structured around multi-user interaction, shared presence, or collective performance Piitulainen et al. (2022); **Educational Narrative**: A VR narrative system designed primarily to support learning objectives Calvert and Hume (2022); **Rehabilitative Narrative**: A VR storytelling system designed to facilitate therapeutic or clinical rehabilitation processes Tao et al. (2021).

Step 5e: We identify the following space-related user experiences of these VR narrative systems based on our understanding of the narrative systems: **Bodily Agency** = Users participating in narratives through body navigation and interaction in VR space Kilteni et al. (2012). **Emotional Engagement** = Emphasis on the user’s emotional engagement with the space and narrative content is one of the key components of narrative engagement Busselle et al. (2009). **Social Presence** = Users perceive others as ‘real’ in the digital environment Berkman and Akan (2019).

Step 6e: We added them into our taxonomy in iteration 1 and identified which narrative systems has each characteristic: **Taxonomy2 = {Participation (Bodily Agency, Emotional Engagement, Social Presence)} + Taxonomy1**

Step 7: Given the addition of new elements, the process should be continued.

2.3. Iteration 3:

Step 3: To broaden perspective, a conceptual-to-empirical strategy was adopted.

Step 4c: Following Nickerson et al. (2013), we identified a new high-level distinction based on our understanding of the user experience of VR narrative systems: the *Audience Dimension*, representing whether the system targets **Universal** users or **Specific** groups (Tao et al. 2021).

Step 5c: This dimension was identified because user age is a widely recognised factor in user-centred design Monk (2000).

Step 6c: We added them into our taxonomy in iteration 3: **Taxonomy3 = {Audience (Universal, Specific)}+ Taxonomy2**

Step 7: This revealed the relevance of considering user inclusivity in VR narrative experiences and pointed toward further refinement.

2.4. Iteration 4:

Step 3: We extended our empirical-to-conceptual analysis by examining additional VR narrative systems.

Step 4e: We select the following additional VR narrative systems from the literature Hadjipanayi et al. (2024) and Vallance and Towndrow (2022): **Reflective Narrative**: immersive experiences that encourage personal memory reflection and identity processing Bahng et al. (2020); **Performative Narrative**: embodied, improvisational, or co-performed experiences involving dynamic audience participation Gatti (2022); **Speculative Narrative**: experiences that position the user in imagined futures or alternate realities through spatial storytelling Murray (2017).

Step 5e: We identify the following space-related user experiences of these VR narrative systems based on our understanding of the narrative systems. We added them into our taxonomy in iteration 1 and identified which narrative systems has each characteristic: From these sources, we identified four new space-related characteristics: **Alterity**=encountering alternate selves (Hadjipanayi et al. 2024); **Perceived Realism**=experiencing the space as coherent and authentic (Vallance and Towndrow 2022), **Reflection**=relating spatial narratives to autobiographical memory (Bahng et al. 2020); and **Chronotopic Presence**=embodied co-presence across temporalities (Vallance and Towndrow 2022).

Step 6e: These characteristics were then mapped to their corresponding dimensions: within *Location* , we added **Perceived Realism** and **Chronotopic Presence**, and within the newly established *Resonance*, we added **Alterity** and **Reflection**. With these additions, the taxonomy was updated to include the new *Resonance* alongside the existing ones, thereby expanding its explanatory scope.

Taxonomy4 = {Location (Chronotopic Presence), Resonance (Alterity, Reflection)} + Taxonomy3

Step 7: Since one more dimension was created in this iteration, at least onemore iteration is needed.

2.5. Iteration 5:

Step 3: We extended our empirical-to-conceptual analysis by examining additional VR narrative systems.

Step 4e: Drawing on Austin's User-Centred Narrative Environment model (Austin 2020) and narrative cognition theory in VR environments (Ryan 2015).

Step 5e: To capture users' grasp of narrative structure and causality, we composed characteristics: **Narrative Understanding**, **Spatial Reasoning**, and **Memory Recall** (Ryan 2015).

Step 6e: We added them into our taxonomy in iteration 4: **Taxonomy5 = {Cognition (Narrative Understanding, Spatial Reasoning, Memory Recall)} + Taxonomy4**

Step 7: These additions expanded the taxonomy to encompass users' narrative comprehension and spatial-cognitive processing.

2.6. Iteration 6:

Step 3: We continued with the empirical-to-conceptual approach to examine user experience.

Step 4e: We reviewed all literature from the previous five iterations to identify additional VR narrative systems: **Dramatic Narrative**: emphasizing conflict, character development, and emotional tension (Guo et al. 2024); **Therapeutic Narrative**: promoting psychological healing or behavioral change (Hadjipanayi et al. 2023); **Affective Narrative**: prioritizing emotional engagement (Irshad and Perkis 2020); **Gamified Narrative**: using game elements to enhance engagement or learning (Zhang and A. Bowman 2022); and **Heritage Narrative**: conveying cultural or historical heritage through immersive storytelling (Hajahmadi et al. 2024).

Step 5e & 6e: We cannot identify any new character-istics and dimensions from these applications. We group the new applications,along with the previous applications,using the existing characteristics anddimensions as shown in 1.

Step 7: We have added no new dimensions with this iteration and we have examined a large sample of mobile applications. Hence, the ending conditions are met. The method ends at this point.

2.7. Findings and Discussion

The analysis of Figure 1 demonstrates that the taxonomy encompasses 16 mutually exclusive

Space-related User Experience in Literature of VR Narrative Systems	Sensation		Location				Resonance		Participation			Audience		Cognition		
	E	P	SoS	SaP	PR	CP	A	R	BA	EE	ScP	U	Spc	NU	SR	MR
Structured Narrative		X	X					X		X		X		X		
Perceptive Narrative	X			X				X		X		X			X	
Cocreative Narrative	X		X				X		X			X				X
Environmental Storytelling	X		X				X		X			X		X		
Social Narrative		X		X			X				X	X		X		
Educational Narrative		X	X				X		X				X	X		
Rehabilitative Narrative	X		X				X		X				X			X
Reflective Narrative		X				X	X			X		X				X
Performative Narrative	X				X		X				X	X			X	
Speculative Narrative	X					X		X	X			X			X	
Dramatic Narrative		X				X	X			X		X		X		
Therapeutic Narrative		X			X			X		X			X			X
Affective Narrative		X			X			X		X		X		X		
Gamified Narrative		X	X				X				X	X		X		
Heritage Narrative		X	X				X			X		X			X	

E = Embodiment; P = Presence; SoS = Sense of Space; SaP = Spatial Presence; PR = Perceived Realism; CP = Chronotopic Presence; A = Alterity; R = Reflection; BA = Bodily Agency; EE = Emotional Engagement; ScP = Social Presence; U = Universal; Spc = Specific; NU = Narrative Understanding; SR = Spatial Reasoning; MR = Memory Recall

Figure 1: *Taxonomy of Spatial User Experience in VR Narrative Systems after all Iterations*

characteristics across 6 dimensions of spatial user experience in VR narrative systems.

Structured Narrative and Educational Narrative align strongly with *Location* and *Cognition*, where spatial orientation and reasoning ensure coherence and support learning (Hartmann et al. 2015; Ryan 2015; Austin 2020). Therapeutic Narrative and Reflective Narrative emphasize *Resonance*, particularly through reflection and alterity to foster empathy, identity work, and wellbeing (Bahng et al. 2020; Calvert and Hume 2022). Performative Narrative and Cocreative Narrative foreground *Sensation* and *Participation*, highlighting embodiment, bodily agency, and social presence as central mechanisms of engagement (Weijdom 2022). Speculative Narrative, Dramatic Narrative, and Affective Narrative extend this with emotional engagement and imaginative alterity, emphasizing intensity and transformation (Hadjipanayi et al. 2024; Busselle et al. 2009).

Gamified Narrative and Heritage Narrative illustrate hybrid pathways: Gamified Narrative combines embodiment, orientation, and active involvement, while Heritage Narrative connects perceived realism with cultural recall and autobiographical memory (Vallance and Towndrow 2022; Tao et al. 2021). Overall, the taxonomy reveals distinct yet patterned alignments: coherence and reasoning in Structured Narrative and Educational Narrative, resonance in Therapeutic Narrative and Reflective Narrative, and agency in Performative Narrative and Cocreative Narrative. This mapping highlights the explanatory power of the taxonomy in showing how VR narrative systems orchestrate embodied, affective, and cognitive experiences through spatial design.

3. DISCUSSION AND CONCLUSION

This study develops a taxonomy of space-related user experiences (SRUX) in VR narrative systems, integrating constructs from presence (Slater and Wilbur 1997), narrative immersion (Ryan 2015), embodied narrative (Dooley 2024b), and spatial cognition (Vallance and Towndrow 2022). It shifts attention from system attributes (Hameed et al. 2024) to user engagement, showing how narrative systems orchestrate perceptual, affective, and cognitive pathways through spatial design.

Practically, the taxonomy provides a vocabulary for design and evaluation—for instance, using *Resonance* to evoke empathy and autobiographical reflection (Bahng et al. 2020), or *Location* to support learning through spatial sequencing (Austin 2020). Mapping system types to SRUX dimensions supports aligning design choices with experiential outcomes.

Limitations and Future Work: The taxonomy was derived from a literature-based synthesis and is limited to selected databases and English-language sources. Its claims remain provisional without empirical validation. Future research should test and refine the taxonomy through controlled studies and qualitative inquiries, broaden its cultural and linguistic scope, and integrate iterative design feedback to ensure robustness and applicability across VR contexts.

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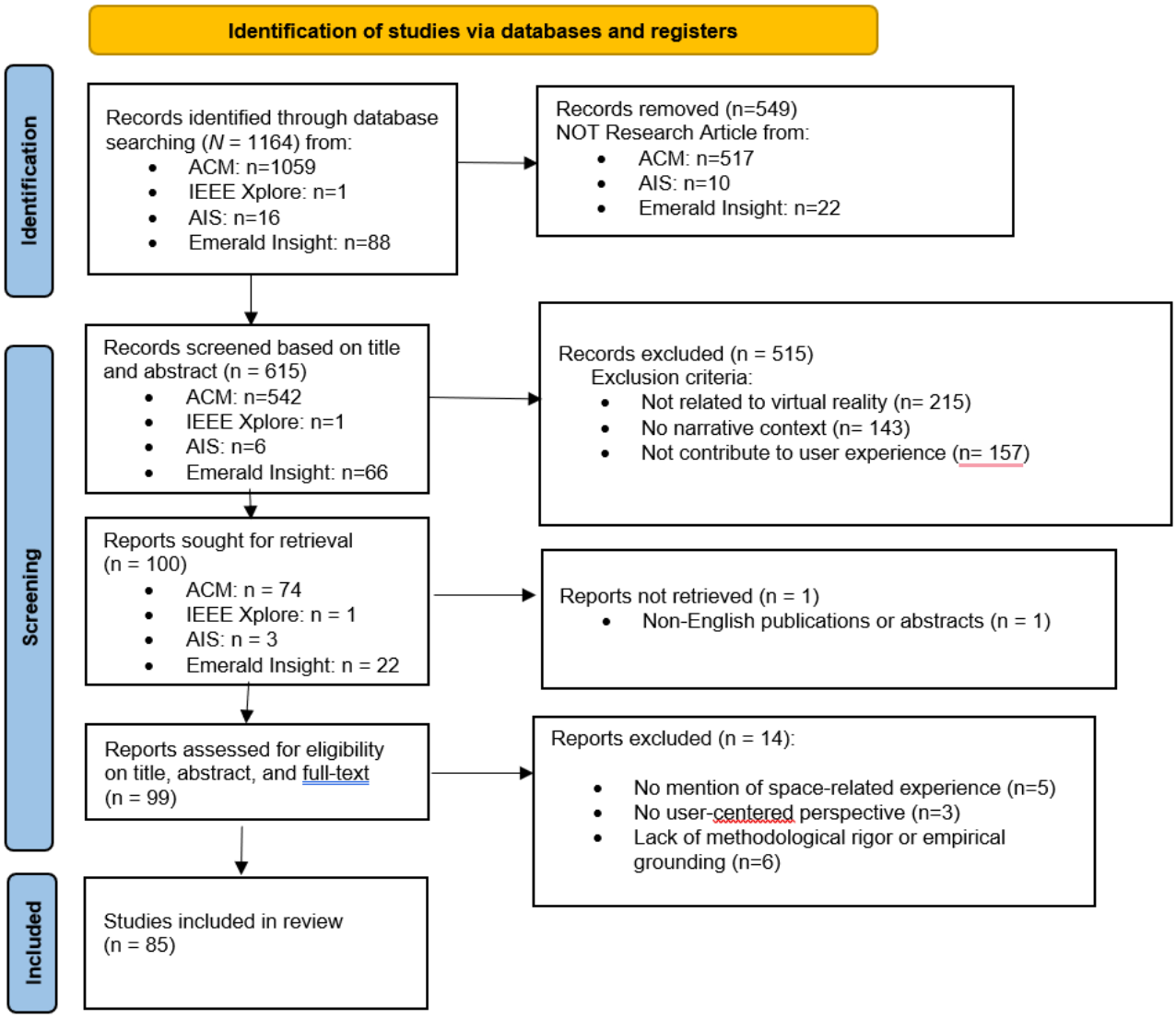

Figure 2: *APPENDIX A: PRISMA for Scoping Review of Iteration 1*

Iteration	Approach	Newly Identified Features / Concepts	Structural Changes	Example References
Iteration 1	Empirical-to-Conceptual	Embodiment, Presence, Sense of Space, Spatial Presence	Established two initial dimensions: Sensation and Location	Bosman et al. (2025), Berkman & Akan (2019), Kuksa & Childs (2014), Hartmann et al. (2015)
Iteration 2	Empirical-to-Conceptual	Bodily Agency, Emotional Engagement, Social Presence	Introduced the Participation dimension	Weijdom (2022), Busselle & Bilandzic (2009), Piitulainen et al. (2022)
Iteration 3	Conceptual-to-Empirical	Universal vs. Specific audience targeting	Introduced the Audience dimension	Tao et al. (2021)
Iteration 4	Empirical-to-Conceptual	Alterity, Reflection, Sensory Engagement, Perceived Realism, Chronotopic Presence	Added the Resonance dimension; Expanded Location	Bahng et al. (2020), Hadjipanayi et al. (2024), Calvert & Hume (2022)
Iteration 5	Conceptual-to-Empirical	Narrative Understanding, Spatial Reasoning, Memory	Added Understanding and	Ryan (2015), Vallance & Towndrow (2022)
Iteration 6	Empirical-to-Conceptual	Confirmed coverage across diverse VR narrative types (gamified, heritage,	No new features; structure validated	Zhang & Bowman (2022), Hajahmadi et al. (2024)

Figure 3: *APPENDIX B: Iteration Process of Taxonomy Development Methodology*