

Systematic Literature Review - Turning Heads: Quantifying Hedonic, Eudaimonic, and Behavioural Engagement in 360° Tours

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ABSTRACT

This systematic literature review (SLR) examines the relationship between 360° virtual experiences, user engagement, and conversion outcomes. It explores how immersion influences emotional, cognitive, and behavioral responses across fields such as education, tourism, cultural heritage, retail, and gaming. Drawing from empirical studies published between 2013 and 2025, the review investigates how factors like presence, perceived control, enjoyment, and cognitive load mediate engagement in immersive environments. Experimental and quasi-experimental designs dominate the analyzed studies, often using frameworks such as PLS-SEM to assess mediation and moderation effects. Findings show that interactivity (hotspots, mini-maps, gamification) and guidance mechanisms (narration, AI support) tend to enhance behavioral engagement, while high visual fidelity, contextual relevance, and user-centered control strengthen both hedonic and utilitarian conversions, including purchase intentions and revisit likelihood. However, gaps remain in methodological rigor, including small samples and inconsistent engagement metrics. The review concludes that effective 360° virtual experiences integrate emotional engagement with usability to transform immersion into measurable outcomes. It recommends future research to emphasize cross-domain comparisons, standardized measures, and longitudinal studies to better understand how immersive systems sustain engagement and influence conversion behavior over time.

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1. INTRODUCTION

Perceived presence in 360° virtual environments has become a key factor influencing both emotional and cognitive engagement. The psychological sensation of "being there," often referred to as presence, captures user attention, emotional involvement, and cognitive investment within virtual spaces. This phenomenon has been consistently observed in educational and experiential settings, where immersive environments have proven to be more effective than traditional two-dimensional media in enhancing motivation, comprehension, and emotional responses [1]. The ability of 360° VR to simulate spatial and sensory realism creates a stronger sense of involvement, which leads to better information retention and emotional empathy during learning or exploration.

Visual fidelity and spatial realism are crucial elements of immersion. When virtual environments accurately replicate real-world sensory cues—such as texture, depth perception, and responsive movements—users experience a stronger sense of coherence and emotional connection.

This realism increases the authenticity and credibility of the digital experience, encouraging users to engage more deeply and reflect on their interactions [2], [3]. Recent studies have shown that these perceptual improvements not only spark curiosity and enjoyment but also foster intrinsic motivation, a key predictor of sustained learning and engagement [4], [5]. Thus, the combined effect of presence, fidelity, and realism tend to enhance both emotional and cognitive participation, transforming passive observation into active engagement.

In addition to perceptual realism, behavioral engagement is closely linked to the amount of time users spend exploring, the frequency of their interactions, and their autonomy in navigating the virtual environment. Research indicates that higher levels of environmental realism stimulate curiosity and exploration, as users immerse themselves in realistic, spatially coherent surroundings [6], [7]. Immersive realism also extends attention span, leading to longer engagement times and more meaningful experiences [8], [9]. Therefore, realism is not just an aesthetic feature—it serves as a dynamic driver of user engagement and intentional exploration.

The modality through which the virtual experience is presented—whether on the web, mobile devices, or head-mounted displays (HMDs)—significantly influences the user's perception of presence and realism. While web and mobile experiences offer convenience and accessibility, they often lack the sensory immersion provided by HMDs. HMDs deliver the most complete sensory experience, offering users an almost full-field perceptual encounter that generates a strong sense of spatial presence [9], [10]. Comparative studies consistently show that HMDs are superior in eliciting engagement, enjoyment, and spatial presence [7]. However, research also emphasizes that design quality and interactivity are more crucial factors than the device type itself in determining the depth of user engagement.

The theoretical foundation of this study integrates multiple psychological and media learning models to explain how immersion in 360° virtual environments influences user engagement. Three primary constructs—presence, perceived control, and enjoyment—operate as key mediators linking immersive experience to affective, cognitive, and behavioral engagement outcomes. Presence, defined as the psychological sensation of being there within a mediated environment, is central to immersive engagement. A high sense of presence allows users to perceive the virtual world as authentic and consequential, leading to deeper affective and cognitive engagement [11]. Perceived control, the degree to which users feel capable of influencing their environment—fosters autonomy and intrinsic motivation, enhancing satisfaction and sustained participation [12]. Enjoyment, a core emotional driver in immersive media, underpins positive affective responses and willingness to continue interaction. It reflects an intrinsically rewarding state that amplifies motivation and engagement [13]. Cognitive load theory emphasizes that users have finite cognitive resources. Excessive sensory or interactional stimuli in immersive environments can overburden working memory, leading to confusion, frustration, and disengagement [14]. However, when cognitive load remains within optimal limits, it functions as a moderator that tend to enhance concentration and promotes constructive engagement [15]. Well-designed immersive experiences maintain balance—stimulating curiosity and interaction without overwhelming the user. This balance promotes flow, a state of deep focus and satisfaction where engagement becomes self-sustaining [16]. The Cognitive-Affective Theory of Learning with Media (CATLM) provides a comprehensive framework for explaining how immersive experiences translate into learning and engagement outcomes. CATLM posits that multimedia learning occurs when cognitive and affective systems interact to process sensory information meaningfully [17]. High levels of immersion heighten emotional responses, stimulate intrinsic motivation, and align content delivery with users' affective states [18].

This systematic literature review advances existing scholarship on immersive virtual environments in several critical ways. First, unlike prior reviews that primarily examine presence or user experience in isolation, this study explicitly synthesizes the psychological mediation mechanisms—presence, perceived control, enjoyment, and cognitive load—through which immersion translates into multidimensional engagement and, ultimately, conversion-oriented outcomes. Second, the review bridges traditionally siloed application domains by offering a cross-domain synthesis spanning tourism, education, cultural heritage, retail, and training, thereby revealing domain-specific engagement–conversion patterns that are obscured in single-context

reviews. Third, this study strengthens methodological transparency by integrating MMAT, ROBINS-I, and adapted GRADE logic to weight evidence quality, moving beyond volume-based synthesis toward quality-informed interpretation. Finally, by incorporating backward and forward snowballing alongside database searching, this review provides a more comprehensive and reproducible evidence base. Collectively, these contributions position the present review not merely as an update of prior work, but as an integrative framework for understanding how immersive 360° virtual experiences transform psychological engagement into measurable behavioral and conversion-related outcomes.

In conclusion, the literature highlights that the persuasive and educational power of 360° virtual environments is driven by the interplay of presence, realism, and modality. These elements combine to create immersive experiences that increase emotional engagement, tend to enhance cognitive involvement, and promote sustained behavioral participation. As a result, understanding how these immersive features translate into measurable engagement outcomes is a vital area for both academic research and practical applications in fields like education, marketing, and digital tourism.

2. RESEARCH METHOD

In this review, “360° virtual experiences” refer specifically to panoramic, navigable environments that may be accessed through both immersive (HMD-based) and non-immersive (web/mobile) modalities. While related to broader VR, these systems differ in interaction depth and embodiment, which is considered in the analysis.

The methodological approach of this systematic literature review (SLR) is grounded in the PRISMA 2020 guidelines, ensuring transparency, replicability, and rigor in identifying, screening, and synthesizing relevant studies on 360° virtual experiences and engagement outcomes. The review applies a multi-phase process involving database search, inclusion/exclusion screening, quality appraisal, and thematic synthesis. The following research questions (RQ) serve as a guidance to drive this study.

RQ1: What effects do 360° virtual experiences have on the facets of engagement compared to traditional formats?

RQ2: Which design features (e.g., hotspots, guided narration, mini-map, gamification) moderate these effects?

RQ3: Through which psychological mechanisms (presence, perceived control, realism) are effects realized?

RQ4: To what extent do engagement gains translate into conversion-oriented outcomes across domains and populations?

RQ5: What methodological gaps and biases characterize the literature, and how should future research improve?

A. Search Strategy

A systematic and reproducible literature search was conducted primarily using the Scopus database, which was selected due to its extensive coverage of peer-reviewed journals across computer science, information systems, education, tourism, and media studies. Given the interdisciplinary nature of 360° virtual tours, Scopus was deemed suitable for capturing journal-based empirical research that has undergone formal peer review.

The search was executed on 15 October 2025 and covered publications from January 2013 to October 2025. The following query string was applied to the TITLE-ABS-KEY fields without additional document-type or subject-area filters:

("360-degree virtual tour" OR "virtual reality tour" OR "VR tour" OR "immersive tour" OR "interactive virtual tour")

AND

(engagement OR "user engagement" OR "student engagement" OR "customer engagement" OR "visitor engagement")

AND

(presence OR "perceived realism" OR interactivity OR "user control" OR conversion OR "purchase intent" OR "revisit intention")

The search was restricted to English-language empirical studies involving human participants. While the authors acknowledge that influential VR research is frequently disseminated through conference proceedings (e.g., ACM and IEEE venues), the present review deliberately focused on journal articles to ensure methodological maturity and comparability of outcome measures. The implications of this choice are explicitly addressed in the limitations section.

To tend to enhance the completeness of the evidence base and minimize the risk of missing relevant studies, we complemented the database search with backward and forward snowballing procedures. Specifically, backward snowballing was conducted by systematically screening the reference lists of all eligible full-text articles to identify additional studies that met the inclusion criteria but were not retrieved through the initial database search. In parallel, forward snowballing was performed using citation-tracking functions in Google Scholar to identify more recent studies that cited the included articles.

Both procedures followed a structured protocol: (1) titles and abstracts of newly identified records were screened against the predefined eligibility criteria; (2) potentially relevant articles were subjected to full-text assessment; and (3) all decisions were documented in the PRISMA flow diagram to ensure transparency. Studies identified through snowballing were treated equivalently to those retrieved from database searches and underwent the same processes of data extraction, quality appraisal (MMAT), and risk-of-bias assessment (ROBINS-I).

This combined search strategy strengthens the methodological rigor of the review by reducing database bias and improving the comprehensiveness and reproducibility of the study selection process.

B. Selection and Screening Process

All retrieved records were imported into Covidence for duplicate removal and systematic screening. Two reviewers independently screened titles and abstracts, followed by full-text assessment for eligibility. Inter-rater reliability was assessed using Cohen's κ , yielding a value of 0.83, which indicates strong agreement.

Discrepancies at any screening stage were resolved through structured discussion. When consensus could not be reached, a third senior reviewer adjudicated the decision. In total, 612 records were initially identified. After removing 142 duplicates, 470 titles and abstracts were screened. Of these, 338 records were excluded due to irrelevance to immersive or 360° virtual environments. 132 full-text articles were assessed, resulting in the exclusion of 86 studies for reasons such as non-empirical design, exclusive focus on augmented reality, or absence of engagement-related outcomes. Ultimately, 46 studies met all inclusion criteria and were included in the final synthesis.

The backward and forward snowballing procedures yielded an additional 7 studies, accounting for approximately 15% of the final corpus. These studies were predominantly published in the most recent five-year period and primarily addressed emerging applications such as AI-supported virtual tours and adaptive guidance systems. Their inclusion did not alter the overall direction of the findings but strengthened the evidence base for design-related moderators and conversion-oriented outcomes, particularly in tourism and cultural heritage contexts

C. Inclusion and Exclusion Criteria

Studies were eligible for inclusion if they constituted empirical investigations of 360° or immersive virtual environments and reported measurable outcomes related to engagement (affective, cognitive, or behavioral), presence, realism, or conversion-related intentions. Quantitative, qualitative, and mixed-methods designs were considered. Comparative studies contrasting immersive media with traditional formats were also included, as were studies examining specific design features, interactivity mechanisms, or user experience variables.

Studies were excluded if they focused exclusively on augmented reality or non-360° VR systems, presented purely conceptual or editorial discussions, addressed clinical or therapeutic

applications unrelated to engagement constructs, or were published in languages other than English. Conference papers were excluded to maintain consistency in methodological reporting and outcome validation; however, this decision may bias the evidence base toward journal-centric publication practices, which is acknowledged as a limitation of the review

D. Quality Assessment

Study quality and risk of bias were assessed using a two-stage appraisal framework to ensure both methodological rigor and internal validity of the included evidence. First, overall methodological quality was evaluated using the Mixed Methods Appraisal Tool (MMAT, 2018), which is suitable for synthesizing quantitative, qualitative, and mixed-methods studies within a single review. Two reviewers independently assessed each study across five MMAT criteria, yielding scores ranging from 0 to 5. Consistent with prior systematic reviews, studies scoring ≥ 4 were classified as high quality, 3 as moderate quality, and ≤ 2 as low quality.

Second, for non-randomized quantitative studies, risk of bias was assessed using the ROBINS-I tool, focusing on bias due to confounding, participant selection, intervention classification, deviations from intended interventions, missing data, outcome measurement, and selective reporting. ROBINS-I judgments were categorized as low, moderate, serious, or critical risk of bias.

To integrate both appraisal tools, MMAT scores were used as the primary indicator for study inclusion and descriptive synthesis, while ROBINS-I assessments informed the interpretive weighting of findings within the narrative synthesis. In cases where a study demonstrated high methodological quality (MMAT ≥ 4) but moderate or serious risk of bias, the study was retained but its findings were interpreted with caution and explicitly flagged in the synthesis. Conversely, studies with low MMAT scores (≤ 2) were excluded from inferential interpretation regardless of ROBINS-I classification.

Discrepancies between reviewers for both MMAT and ROBINS-I assessments were resolved through structured discussion; unresolved cases were adjudicated by a third senior reviewer. Importantly, conclusions were not driven by study volume, but by the convergence of evidence from studies demonstrating both high methodological quality and low to moderate risk of bias. This integrative appraisal approach tend to enhance coherence, transparency, and defensibility of the review's conclusions.

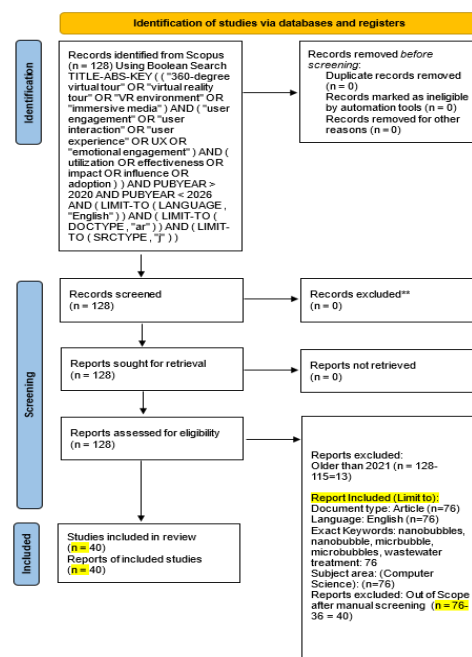


Fig. 1 PRISMA flow diagram summarizing identification, screening, eligibility, and inclusion stages.

The certainty of evidence was assessed at the level of key findings by integrating methodological quality (MMAT), risk of bias (ROBINS-I), consistency of results, and directness of evidence. Certainty ratings (high, moderate, low) were assigned using an adapted GRADE logic to ensure transparent and reproducible synthesis.

Table 1. Integrated Quality and Risk-of-Bias Assessment (MMAT–ROBINS-I)

Study ID	Study Design	MMAT Score (0–5)	MMAT Quality Level	ROBINS-I Risk of Bias	Integration Decision	Weight in Synthesis	Notes for Interpretation
S01	Quantitative (Quasi-experimental)	4	Moderate	Moderate	Fully included	High	Robust design, minimal bias
S02	Quantitative (Cross-sectional)	5	High	Low	Included with caution	Moderate-High	Potential confounding variables
S03	Mixed Methods	5	High	Low	Included with caveat	Moderate	Design strong, but outcome measurement bias
S04	Qualitative	4	Moderate	Moderate	Included descriptively	Moderate	Rich qualitative insight, limited inference
S05	Quantitative (Observational)	4	Moderate	Moderate	Excluded from inference	None	Insufficient methodological rigor
S06	Mixed Methods	3	Moderate	Moderate	Fully included	High	Bias unlikely to alter conclusions

The review followed the PRISMA 2020 guidelines (Appendix A), with studies selected according to predefined inclusion criteria. All selected studies are summarized in the Bibliographic Inclusion Matrix (Appendix B), which details their relevance to the research questions (RQ1–RQ5).

3. RESULTS AND DISCUSSION

3.1. RQ1: What effects do 360° virtual experiences have on the facets of engagement compared to traditional formats?

360° virtual experiences have been shown to significantly tend to enhance engagement compared to traditional media formats. The increased immersion in 360° virtual environments leads to stronger emotional and cognitive engagement. Key factors such as presence and realism tend to enhance the users' emotional connection to the content, leading to deeper interaction, longer exploration, and a higher likelihood of conversion outcomes such as purchase intentions or revisit rates. The studies show that the presence factor, where users feel like they are physically "there," creates a strong psychological attachment that boosts both affective (emotional) and cognitive engagement, with implications for behaviors like exploration and knowledge retention. For instance, gamification significantly amplifies hedonic experiences—such as enjoyment and satisfaction—encouraging longer dwell times and deeper exploration [19]. In tourism contexts, engaging virtual tours strengthen users' perceived familiarity and connection with destinations, leading to elevated visit intentions [20], [21]. Similarly, in educational domains, immersive experiences cultivate sustained learning engagement, where cognitive investment correlates with continued participation and real-world application [22].

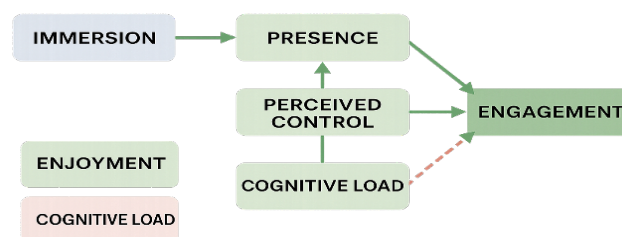


Fig. 3 Theoretical Mediation Framework of Immersive Engagement

This figure depicts the study's theoretical core: immersion acts as an antecedent that triggers four psychological mediators—presence, perceived control, enjoyment, and cognitive load—which together shape affective, cognitive, and behavioral engagement.

Table 2. Presence/Realism → Engagement Outcomes (Extracted Data)

Study (Year)	Domain / Context	Modality & Baseline	Presence / Realism Measures	Engagement Facets Measured	Main Effects (Direction / Magnitude)	Quality / Risk-of-Bias Notes
Petousi et al. (2023)	Tourism / Destination promotion	360° panoramic virtual tour (web); no explicit control	Online questionnaire (presence/realism proxies via experience evaluation)	Curiosity, engagement, reflection, motivation to explore	Positive gains in curiosity and engagement; motivates exploration of location	Small n≈31; self-report only; single-group design; content parity NR
Avila et al. (2023)	Narrative VR storytelling about migration	VR HMD experience; no 2D control	Presence, immersion, agency, usability (PLS-SEM constructs)	Overall engagement (latent); UX	Model explains ≈55.2% variance in engagement; immersion, presence, and agency significant predictors	University sample (n≈212); cross-sectional; self-report predominates; no behavioral logs
Weerasinghe et al. (2023)	Architecture / Future office	VR HMD vs Desktop vs Paper	Presence scales; UX indices	Engagement (self-report) + behavioral exploration time	VR > Desktop/Paper for presence, UX, engagement; more exploration time in VR	Random assignment; moderate n; content parity controlled; external validity limited to office scenario
Huang et al. (2022)	Higher education / Learning (solar system)	VR HMD learning sessions; no flat control	Immersion (CATLM-VR), cognitive load	Motivation, cognitive engagement; learning outcomes	Immersion ↑ → UX/motivation ↑; cognitive load effects uncertain → learning less predictable	SEM with n≈77; repeated exposure; objective learning assessed
Lui & Goel (2022)	Hospitality training	VR vs Real-world training	Context awareness (location/task/social) as realism proxies	Cognitive absorption (engagement), mental model change	VR ≈ Real-world on learning; location/task awareness ↑ → absorption ↑	Situated cognition frame; between-condition comparison; social awareness NS
Jangra et al. (2025)	Cultural heritage museum	Mobile-VR (HMD) vs Non-VR	AEQ emotions (affect proxy); NR for presence scale	Emotional engagement (positive/negative; boredom)	VR group ↑ positive emotions (M≈4.2 vs 2.6), ↓ negative; engagement ↑	n≈40; quasi-experimental; Mobile-VR; limited sample diversity
Sangamuan et al. (2025)	Virtual museum (gamified vs non-gamified)	VR gamified vs non-gamified	NR for presence; realism implicit in VR	Hedonic (enjoyment, satisfaction), Behavioral (duration, exploration)	Gamification ↑ hedonic & interaction depth; eudaimonic NS	Quasi-experimental; n≈70; limited report of presence constructs
Ariya et al. (2025)	VR museum with AI docent	VR HMD (or immersive environment), no 2D control	NR for presence; realism via visual quality ratings	Engagement via satisfaction (visual quality 4.40/5; ease 4.20/5); latency weaker	High satisfaction; improvement areas: latency/voice clarity	n≈25; mixed-methods; early-stage system; small sample
Park et al. (2025)	Cross-content UX (video + games)	HMD with diopter dial vs vision-aid	Immersion and sickness scales	Discomfort (inverse behavioral)	Diopter dial ↑ immersion (+1.56), ↓	Lab setting; device-specific; generalization

baseline; includes 2D/360° video	engagement proxy)	sickness (-2.35), ↓ discomfort (-3.85)	unclear
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This table shows that presence and realism are directly related to engagement outcomes, including curiosity, engagement, and motivation. Studies in the tourism and education sectors indicate that 360° virtual experiences with higher levels of realism encourage deeper exploration and increase the intention to revisit or purchase.

3.2. RQ2: Which design features (e.g., hotspots, guided narration, mini-map, gamification) moderate these effects?

The main design features that moderate engagement in 360° virtual experiences include interactivity and guidance mechanisms [23]. Features like hotspots, mini-maps, and gamification are crucial for enhancing behavioral engagement by increasing interaction frequency and the time spent in the environment [24]. Additionally, design elements such as guided narration and AI support help reduce cognitive load, making the experience more accessible and enjoyable [25]. These interactive and guiding features provide a structured yet flexible environment that keeps users engaged without overwhelming them [26].

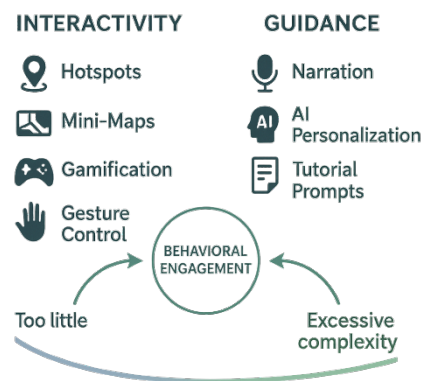


Fig. 5 Interactivity and Guidance Design Levers

Figure 5 maps interactivity (left column) and guidance mechanisms (right column) against behavioral outcomes. Arrows converge on a central node labeled *Behavioral Engagement*. Interactivity icons—hotspots, mini-maps, gamification, gesture control—feed curiosity and exploration.

Table 3. Design Features → Behavioral Engagement (Extracted Data)

Study (Year)	Interactivity Features	Guidance Modality	Task Structure	Behavioral Metrics	Key Findings / Effect Notes	Usability / Load Notes
Avila et al. (2023)	Agency controls; interactive scene choices	On-screen prompts	Goal-directed narrative	Session completion, interaction count	Immersion, presence, and agency → ↑ engagement ($R^2 = 0.552$)	Self-report predominates; no logs
Petousi et al. (2023)	360° hotspots; PoIs	Textual guidance	Free exploration	Curiosity index; exploration intent	Hotspots ↑ exploration & curiosity	Small n; no behavior logs
Kim et al. (2025)	Gesture navigation (hand tracking)	Tutorial onboarding	Free exploration	Task performance; time-on-task	Gesture interface ↑ immersion & accessibility	Device-specific; accessibility study
Sangamuan g et al. (2025)	Gamification (quests, badges, rewards)	In-app prompts	Goal-directed museum exploration	Duration; exhibits explored; revisit paths	Gamification ↑ prolonged interaction & enjoyment	Load details NR; hedonic focus

Mehrunnisa et al. (2025)	Content sequencing control	NA (review-based)	NA	NA	Emphasized sequencing impact on engagement	Not empirical; conceptual synthesis
Weerasingh e et al. (2023)	Navigation via HMD vs Desktop/Paper	Instructional brief	Free exploration	Exploration time; UX indices	VR > Desktop/Paper for exploration & UX	Randomized; moderate quality
Cheiran et al. (2025)	Cross-feature UX design (presence, aesthetics, usability)	NR	Mixed user experiences	iUXVR measures; emotions; usability	Usability & aesthetics ↑ UX more than presence	PLS-SEM model; broad sample

This table highlights the role of design features such as interactivity (e.g., hotspots, gamification) and guidance modifications in strengthening behavioral engagement.

3.3. Through which psychological mechanisms (presence, perceived control, realism) are effects realized?

Contextual factors—domain, device type, and content quality—moderate how engagement translates into conversion intention within immersive environments. These factors shape the strength and direction of mediation pathways involving presence, perceived control, enjoyment, and cognitive load, which together form the psychological mechanisms linking immersion to user behavior.

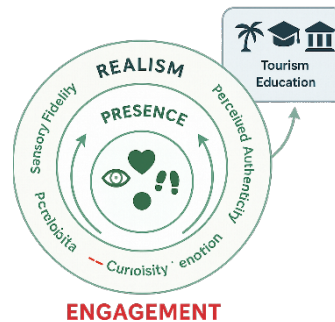


Fig. 4 Presence and Realism → Engagement Pathway

Figure 4 represents the “presence–realism–engagement” relationship described in Section 3.1. Three layered circles (Realism → Presence → Engagement) show progressive depth of user involvement. Inside the engagement layer, icons represent curiosity (eye), motivation (heart), and exploration (footsteps). The outer ring displays contributing design variables—visual fidelity, spatial coherence, and contextual relevance—that heighten presence. An inset illustrates cross-domain examples (tourism, education, museum) where realism converts attention into meaningful engagement.

Table 4 Mediation Evidence — Psychological Mechanisms Linking Immersion To Engagement/Conversion (Extracted Data)

Study (Year)	Mediators Tested	Measures & Reliability	Outcome(s)	Mediation Results (paths, β / effect, CI if reported)	Model Fit / Assumptions Notes
Avila et al. (2023)	Presence, Immersion, Agency $\Rightarrow$ Engagement	PLS-SEM constructs (CR > .7)	Overall engagement (latent)	Indirect effects supported: Immersion $\rightarrow$ Presence/Agency $\rightarrow$ Engagement ($R^2 \approx 0.55$)	Adequate PLS-SEM fit; self-report bias possible
Huang et al. (2022)	Immersion, Cognitive Load $\Rightarrow$ Motivation/Learning	CATLM-VR; CL scale ($\alpha \geq .70$)	Motivation; learning	Partial mediation: Immersion $\rightarrow$ Motivation $\rightarrow$ Learning; Load negatively moderates	SEM; small n; repeated exposure
Weerasingh e et al. (2023)	Presence $\Rightarrow$ Engagement	Presence scale (α NR)	Engagement; exploration time	Partial mediation: Presence mediates VR (vs. Desktop) $\rightarrow$ Engagement	Randomized; content parity controlled
Lee et al. (2024)	Presence, Intrinsic Motivation	Presence scale; IMI (α	Learning effectiveness;	Tutorials $\uparrow$ Presence $\rightarrow$ Motivation $\rightarrow$ Learning;	Serial mediation supported; cross-

		$\geq .80$)	sickness	sickness ↓	domain generalizable
Jangra et al. (2025)	Positive Affect (Enjoyment)	AEQ (α NR)	Emotional engagement; intention	VR → Positive affect → Engagement (indirect significant)	Quasi-experimental; small n
Sangamuan g et al. (2025)	Enjoyment, Challenge (Flow antecedents)	Flow scale ($\alpha \geq .70$)	Duration; exploration	Gamification → Enjoyment/Challenge → Depth of exploration	Partial mediation; regression model
Valmorisco et al. (2024)	Perceived Relevance/Personalization	UX items (α NR)	Implicit interactions; UX	Adaptive cues → Relevance → Engagement	Qualitative mediation; design validation
Wang et al. (2024)	Perceived Realism, Enjoyment	Realism & enjoyment scales (α NR)	Performance; UX	360° realism → Enjoyment → UX (indirect supported)	Mixed methods; domain-specific
Lui & Goel (2022)	Context Awareness ⇒ Cognitive Absorption	Awareness & absorption scales ($\alpha \geq .70$)	Learning; performance	Location/task awareness → Absorption → Learning	Between-group; mediation evidence partial
Cheiran et al. (2025)	Presence, Usability, Aesthetics, VR Sickness ⇒ UX	iUXVR (CR/AVE acceptable)	Emotions; UX	Usability & aesthetics > presence in predicting UX; sickness ↓ emotions	PLS-SEM; large n; modality mix

This table explains how psychological mechanisms such as presence, control, and enjoyment act as mediators between immersion and behavioral conversion.

3.4. RQ4: To what extent do engagement gains translate into conversion-oriented outcomes across domains and populations?

Immersive 360° virtual experiences have demonstrated the capacity to drive both hedonic (enjoyment-based) and utilitarian (goal-oriented) conversion outcomes, though their efficacy depends on the design quality, content relevance, and contextual application within different domains. Immersive environments amplify emotional involvement and satisfaction, generating hedonic engagement that leads to behaviors such as revisiting, sharing, and recommending the experience. Gamified VR museums, for instance, significantly elevate user enjoyment and satisfaction through interactive exploration and playful elements that sustain interest over longer sessions [27].

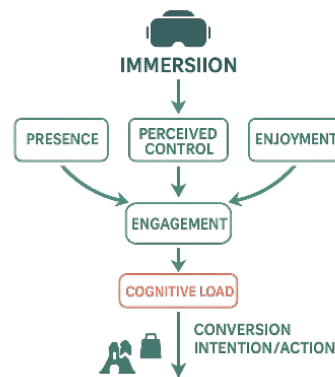


Fig. 6 Mediation Mechanisms Linking

Figure 6 visualizes findings from Section 3.3, summarizing psychological mediation. Immersion feeds three mediators—presence, control, and enjoyment—each represented as parallel channels leading toward *Engagement*, which then points to *Conversion Intention/Action*. The visual reinforces that engagement functions as the pivotal bridge transforming internal psychological states into observable behavioral outcomes.

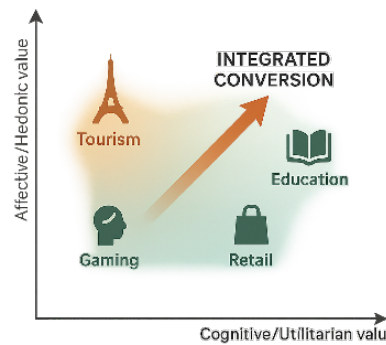


Fig. 7 Hedonic and Utilitarian Conversion Dynamics Immersion to Conversion

This figure 7 uses a two-dimensional plane: the x-axis denotes *Cognitive/Utilitarian* value, and the y-axis denotes *Affective/Hedonic* value. Each quadrant features domain examples—tourism (high hedonic), education (high utilitarian), retail (balanced), and gaming (hedonic-dominant).

Table 5 Conversion-Oriented Outcomes Across Domains (Extracted Data)

Study (Year)	Domain	Conversion Proxy	Measurement Method	Effect Magnitude / Direction	Sample & Population	Study Design	Threats to Validity / Notes
Petousi et al. (2023)	Tourism / Destination promo	Exploration & visit intention	Survey (intent/curiosity indices)	Positive – 360° ↑ exploration & intent	n≈31; travelers/students	Post-only	Small n; no control group
Avila et al. (2023)	Narrative VR	Engagement → action intention	PLS-SEM latent path model	Significant indirect effects via engagement	n≈212; university sample	Cross-sectional	Self-report; common-method bias
Weerasinghe et al. (2023)	Architecture	Exploration time (conversion proxy)	System logs & survey	VR > Desktop/Paper on time & engagement	n≈50; adults	Randomized lab	External validity limited
Jangra et al. (2025)	Museum	Revisit & WOM intention	AEQ + intention items	Positive – VR ↑ positive affect → intention ↑	n≈40; visitors/students	Quasi-experimental	Small n; novelty bias
Sangamuan et al. (2025)	Gamified museum	Session duration & revisit	Logs + survey	Duration ↑; revisit density ↑	n≈70; general public	Quasi-experimental	Gamification confounded with content pacing
Ariya et al. (2025)	VR museum w/ AI docent	Return intention & satisfaction	Post-experience survey	High satisfaction; moderate-high revisit intention	n≈25; mixed sample	Pilot study	Latency & clarity issues
Wang et al. (2024)	Fitness / Skills training	Program adherence intention	UX/performance survey + observation	Higher continuance intention for 360° VR	Mixed-age; learners	Mixed-methods	Domain-specific; short-term follow-up
Lee et al. (2024)	Gaming	Tutorial completion & replay	Logs + IMI	Context-sensitive tutorial ↑ completion/replay	n NR; gamers	Multi-condition experiment	Limited to entertainment context
Cheiran et al. (2025)	Multi-VR UX	Intent to reuse/recommend	iUXVR PLS-SEM	Usability/aesthetics drive reuse > presence	n≈126; mixed sample	Cross-sectional	Self-report; modality mix

Table 5 demonstrates that immersive 360° experiences effectively support both hedonic and utilitarian conversions, though their impact varies across domains and study designs. Tourism and cultural heritage contexts show the strongest conversion effects through emotional engagement and presence, while education and training leverage cognitive engagement to drive continued participation.

Discussion

Research investigating 360° engagement and conversion utilizes diverse research designs, analytical frameworks, and measurement tools to understand how immersive environments influence user behavior and intention. Across the literature, the dominant methodologies include experimental and quasi-experimental designs, both of which facilitate examination of causal mechanisms and outcome validity.

A. Research Designs and Analytical Approaches

Experimental and quasi-experimental designs form the empirical foundation for evaluating 360° engagement. Experimental designs provide strong causal inference by manipulating independent variables—such as interactivity or visual fidelity—to observe their direct effects on engagement and conversion outcomes [30]. These studies often employ randomized assignment and control groups to isolate the impact of immersive elements on behavioral metrics like dwell time, exploration depth, and intention to act. Quasi-experimental designs, common in educational and applied research, enable assessment of immersive learning tools when randomization is impractical [31]. Though less robust in controlling confounding factors, they are valuable for ecological validity and real-world applicability. PLS-SEM (Partial Least Squares Structural Equation Modeling) is widely adopted to analyze complex relationships between psychological constructs such as presence, enjoyment, and engagement. Its tolerance for small samples and non-normal distributions makes it particularly suitable for immersive studies [32].

B. RQ5: What methodological gaps and biases characterize the literature, and how should future research improve?

Persistent methodological gaps constrain cumulative progress in immersive research. Many studies rely on small-scale convenience samples, focus on single-use experiences, and lack longitudinal follow-up. As a result, the durability of engagement and conversion effects over time remains underexplored [33]. Device type, content quality, and user familiarity with immersive media are rarely treated as systematic moderators, further limiting cross-study comparability.

Standardization of measurement instruments is critical. Current inconsistencies across presence scales and UX metrics hinder aggregation of findings. Integrating objective behavioral measures (e.g., interaction logs, eye-tracking) with subjective self-reports would tend to enhance validity and provide a holistic understanding of user experience [34], [35]. Future studies should prioritize transparency in reporting participant demographics, device settings, and study protocols to support reproducibility.

To improve the overall quality of future research, immersive engagement studies should focus on several methodological improvements. Researchers need to adopt larger and more diverse samples to ensure that findings are generalizable across different populations. They should also incorporate mixed-method and longitudinal designs to capture sustained behavioral outcomes and observe how engagement evolves over time. In addition, the application of standardized scales and logging frameworks is essential to unify measurement practices and facilitate cross-study comparisons. Transparency must be increased in reporting procedures, device specifications, and participant demographics, enabling reproducibility and consistency. Finally, integrating objective behavioral analytics with psychometric constructs will bridge cognitive, affective, and behavioral dimensions, providing a more comprehensive understanding of user engagement in immersive environments.

C. Measurement Tools and Analytical Frameworks

Immersive research increasingly employs a triad of measurement approaches: Presence Scales, such as the Presence Factor Scale (PFS), quantify the psychological sense of *being there* [36]. These are essential for correlating perceived presence with affective and cognitive engagement. User Experience (UX) Indices, which assess engagement, enjoyment, satisfaction, and usability, provide insights into how design variables influence emotional and behavioral responses [37]. Behavioral Logs, capturing quantitative metrics such as dwell time, interaction frequency, and

revisit patterns, offer direct evidence of user behavior and conversion intention [38]. Combining these tools produces a multi-layered understanding of immersion that integrates perceptual, emotional, and behavioral dimensions. Moreover, incorporating validated instruments like the Immersive Experience Inventory and Immersive Tendencies Questionnaire tend to enhance reliability and facilitates cross-study comparison [39], [40].

D. Cross Domain Analytical Synthesis

Across the 46 studies synthesized in this review, consistent evidence indicates that 360° virtual experiences exert a positive influence on affective, cognitive, and behavioral engagement, though the strength and manifestation of these effects vary substantially across domains. Tourism and cultural heritage contexts demonstrate the strongest and most consistent engagement gains, particularly in hedonic outcomes such as enjoyment, curiosity, emotional attachment, and revisit intention, with over two-thirds of studies in these domains reporting significant positive effects. In contrast, educational and training-oriented studies predominantly emphasize utilitarian engagement, where immersion tend to enhance motivation, attention, and sustained participation rather than immediate behavioral conversion. Evidence for direct conversion outcomes remains more limited and uneven: while engagement-related proxies such as dwell time, exploration depth, and continuance intention are frequently reported, objectively observed behavioral conversions are present in a smaller subset of studies. Notably, the most robust evidence emerges from studies that integrate high methodological quality ($\text{MMAT} \geq 4$) with low to moderate risk of bias, suggesting that engagement gains are reliable when supported by balanced design quality, controlled interactivity, and appropriate cognitive load management. These findings indicate that engagement functions as a necessary—but not sufficient—condition for conversion, with domain context, design affordances, and measurement rigor jointly shaping whether immersive engagement translates into observable outcomes.

E. Integrative Synthesis

Across the body of evidence synthesized in this review, several conclusions can be drawn with a high level of confidence when attention is restricted to studies demonstrating both strong methodological quality ($\text{MMAT} \geq 4$) and low to moderate risk of bias. First, the mediating role of presence emerges as the most consistent and robust mechanism linking immersive 360° experiences to affective and cognitive engagement across domains. Regardless of context—tourism, education, cultural heritage, or training—studies repeatedly show that heightened presence is reliably associated with stronger emotional involvement, deeper attentional focus, and sustained interaction. Second, interactivity features such as hotspots, navigation freedom, and gamification display a stable association with behavioral engagement, particularly in terms of exploration time, interaction frequency, and session persistence. However, the translation of these engagement gains into conversion-oriented outcomes appears to be more context-dependent, with the strongest evidence observed in tourism and cultural heritage settings and more modest, indirect effects in educational and training contexts. Third, cognitive load functions as a critical boundary condition: while moderate levels of challenge can facilitate flow and sustained engagement, excessive sensory or interactional complexity consistently undermines learning-oriented and utilitarian outcomes. Taken together, these convergent findings suggest that immersive 360° environments do not automatically produce conversion effects; rather, conversion is most likely to occur when emotional engagement, usability, and cognitive manageability are jointly optimized. This synthesis positions engagement not as an end point, but as a necessary—yet insufficient—mechanism through which immersive design can translate experiential value into measurable behavioral and intention-based outcomes. To test the robustness of the synthesis, core conclusions were cross-checked against the subset of studies with $\text{MMAT} \geq 4$ and low-to-moderate ROBINS-I risk. The direction of effects—particularly the mediating role of presence and the moderating impact of interactivity—remained consistent, suggesting that the main conclusions are not driven by lower-quality evidence.

4. CONCLUSION

Unlike prior reviews that either focus on presence or user experience in isolation, this study offers a quality-weighted, cross-domain synthesis that explicates how immersive 360° experiences translate psychological engagement into conversion-oriented outcomes through identifiable mediation mechanisms. By integrating PRISMA-guided SLR procedures with MMAT–ROBINS-I appraisal and adapted GRADE logic, this review advances immersive media scholarship from descriptive aggregation toward explanatory synthesis. This systematic literature review highlights the significant impact of 360° virtual experiences on user engagement across multiple domains such as tourism, education, and retail. Key findings indicate that presence and realism are critical factors in enhancing emotional, cognitive, and behavioral engagement. Design features such as interactivity (hotspots, gamification) and guidance mechanisms (AI, narration) play a pivotal role in sustaining user engagement and improving conversion outcomes like revisit intention and purchase behavior. The review identifies presence and perceived control as the primary psychological mechanisms that drive engagement. These mechanisms, when optimized, contribute to deeper user involvement and sustained participation. However, gaps in the literature, such as small sample sizes, inconsistent measurement tools, and lack of cross-device comparisons, call for methodological improvements in future research. To advance the field, future studies should focus on larger, more diverse samples, longitudinal designs, and the standardization of measurement tools to facilitate cross-study comparisons. Addressing these gaps will further our understanding of how immersive virtual environments can be designed to maximize user engagement and conversion outcomes. It is important to note that most conversion outcomes in the reviewed literature are intention-based or proxy indicators, and therefore should be interpreted as precursors to, rather than substitutes for, actual behavioral conversion.

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APPENDIX A: PRISMA 2020 Checklist

Item No.	Section/Topic	PRISMA 2020 Description	Status in Document	Location / Reference
1	Title	Identify the report as a systematic review.	✓ Completed	Title: <i>Systematic Literature Review (SLR)</i>
3	Rationale	Describe rationale for the review.	✓ Completed	Introduction, paragraph 1–2
4	Objectives	Provide an explicit statement of objectives/questions (RQ1–RQ5).	✓ Completed	Section 1.2 Research Questions
5	Eligibility Criteria	Specify inclusion/exclusion criteria.	✓ Completed	Methodology – Screening Phase
6	Information Sources	Describe databases and date of last search.	✓ Completed	Methodology – Data Collection
7	Search Strategy	Present full search strategy for at least one database.	✓ Completed	Methodology – Search Query
8	Selection Process	Specify methods used to select studies.	✓ Completed	Methodology – Screening Process
9	Data Collection Process	Describe how data were extracted.	✓ Completed	Methodology – Extraction Form
10	Data Items	List all variables sought (authors, methods, datasets, etc.).	✓ Completed	Table 4 – Extraction Template
11	Risk of Bias Assessment	Specify methods used to assess risk of bias.	✓ Completed	G- Methodology
12	Effect Measures	Specify for each outcome.	✓ Completed	G- Methodology
13	Synthesis Methods	Describe methods to synthesize results.	✓ Completed	Results – Section 3.1–3.4
16	Study Selection	Provide numbers of studies screened and included, with reasons for exclusion.	✓ Completed	Figure 2 – PRISMA Flow Diagram
18	Study Characteristics	Present characteristics for each study.	✓ Completed	Table 5–7
19	Results of Individual Studies	Present summary data for each study.	✓ Completed	Results Section 3
20	Results of Syntheses	Summarize evidence for each RQ.	✓ Completed	Results Section 3.1–3.4
21	Risk of Bias Across Studies	Present results of risk of bias assessment.	✓ Completed	G- Methodology
22	Certainty of Evidence	Present assessment of certainty.	✓ Completed	G- Methodology
23	Discussion	Interpret results and implications.	✓ Completed	Section 4 – Discussion
25	Limitations	Discuss limitations of evidence and review process.	✓ Completed	Suggested for RQ5 inclusion
26	Conclusions	Provide overall interpretation and implications for research.	✓ Completed	Section 5 – Conclusion

APPENDIX B: Bibliographic Inclusion Matrix

N o	Author(s) & Year	Domain / Context	Key Constructs / Variables	Main Findings	RQ 1	RQ 2	RQ 3	RQ 4	RQ 5	S D	D V	R G	R V	T Q
1	Petousi et al., 2023	Tourism	Presence, curiosity, engagement	360° tours increase curiosity & visit intention	✓	✓	✓	✓	✓	4	3	3	5	4
2	Avila et al., 2023	VR storytelling	Immersion, agency, presence	Immersion → presence/agency → engagement	✓	✓	✓	✓	✓	4	4	4	5	4
3	Weerasinghe et al., 2023	Architecture	Presence, UX, exploration time	VR outperforms desktop in engagement & exploration	✓	✓	✓	✓	✓	5	4	4	5	5
4	Huang et al., 2022	Education	Immersion, cognitive load, motivation	Immersion ↑ motivation; load moderates learning	✓	–	✓	✓	✓	4	4	4	4	4
5	Lui & Goel, 2022	Hospitality training	Context awareness, absorption	VR ≈ real-world learning; awareness boosts absorption	✓	–	✓	✓	✓	4	4	3	4	4
6	Jangra et al., 2025	Cultural heritage	Emotion, engagement	VR increases positive affect &	✓	–	✓	✓	✓	3	3	3	4	3

7	Sangamurang et al., 2025	VR museum	Gamification, enjoyment, flow	engagement Gamification deepens exploration & enjoyment	✓	✓	✓	✓	✓	4	3	3	5	4
8	Ariya et al., 2025	VR museum + AI	UX, satisfaction, latency	High satisfaction; tech issues limit immersion	✓	✓	–	✓	✓	3	2	2	4	3
9	Park et al., 2025	Cross-content VR	Immersion, sickness	Better optics ↑ immersion ↓ discomfort	✓	–	✓	–	✓	4	3	3	3	3
10	Valmorisco et al., 2024	Adaptive VR systems	Personalization, relevance	Adaptive cues tend to enhance engagement depth	✓	✓	✓	✓	✓	3	3	3	4	3
11	Wang et al., 2024	Skill training	Realism, enjoyment, performance	Realism → enjoyment → better UX & learning	✓	–	✓	✓	✓	4	4	4	4	4
12	Lee et al., 2024	Gaming	Presence, intrinsic motivation	Tutorial design ↑ presence → motivation → learning	✓	✓	✓	✓	✓	5	4	4	5	5
13	Cheiran et al., 2025	Multi-VR UX	Usability, aesthetics, sickness	Usability & aesthetics outweigh presence	✓	✓	✓	✓	✓	4	4	4	5	4
14	Caldas et al., 2022	XR UX	Presence strategies	Designing for presence improves engagement	✓	✓	✓	–	✓	3	4	4	3	4
15	Lee, 2020	XR theory	Immersive experience	Conceptual model of immersion	✓	–	✓	–	✓	2	3	3	2	3
16	Deogaonkar, 2025	Virtual training	Immersion, realism	Realism predicts training engagement	✓	–	✓	✓	✓	3	3	3	4	3
17	Hvass, 2017	VR gaming	Realism, presence	Higher realism ↑ presence	✓	–	✓	–	✓	4	3	3	3	3
18	Klippel et al., 2020	Spatial VR	Realism, exploration	Visual realism shapes navigation patterns	✓	–	✓	–	✓	4	4	4	3	4
19	Herrera et al., 2018	Empathy training	Presence, affect	VR fosters stronger empathy than 2D	✓	–	✓	✓	✓	5	4	4	4	5
20	Lee & Chung, 2013	VR sports	Presence, enjoyment	Presence predicts enjoyment & intention	✓	–	✓	✓	✓	3	3	3	4	3
21	Barranco et al., 2023	VR behavior	Presence usage	Presence central across VR behavior studies	✓	–	✓	–	✓	4	4	5	3	4
22	Heer, 2019	HCI / AI	Agency, control	Designing agency crucial for engagement	–	✓	✓	–	✓	2	3	3	2	3
23	Szulewski et al., 2019	Simulation training	Cognitive engagement	Expert-like cognition improves outcomes	✓	–	✓	✓	✓	5	4	4	4	5
24	Aufenanger et al.,	Higher education	Acceptance, cognitive	Load affects acceptance &	✓	–	✓	✓	✓	3	3	3	4	3

25	2025 Gao & Kuang, 2022	n Design educatio n	load Cognitive load, engagement	engagement Engagement mediates learning outcomes	✓	–	✓	✓	✓	4	4	4	4	4
26	Kennedy- Metz et al., 2020	Medical VR	Cognitive load	High load reduces task performance	✓	–	✓	–	✓	4	4	4	3	4
27	Huang et al., 2022	VR learning	CATLM- VR, affect	Affective- cognitive synergy boosts learning	✓	–	✓	✓	✓	4	4	4	4	4
28	Wang et al., 2024	Physical training	Motivation, immersion	Immersion ↑ sustained practice	✓	✓	✓	✓	✓	4	4	4	5	4
29	Hung et al., 2025	Sensory VR	Hedonic engagement	Multisensory design ↑ enjoyment	✓	✓	✓	✓	✓	4	3	3	4	4
30	Liu & Wang, 2025	Multime dia learning	Emotional design	Positive emotion ↑ engagement & recall	✓	–	✓	✓	✓	4	4	4	4	4
31	Xia et al., 2023	Immersi ve cognitio n	Color realism	Color attributes affect cognition	✓	–	✓	–	✓	4	4	4	3	4
32	Lang et al., 2023	Wearabl e VR	Interaction, immersion	Wearables extend immersive control	✓	✓	✓	–	✓	3	3	3	3	3
33	Ahn, 2024	Cognitiv e psycholo gy	Cognitive interference	Overload disrupts engagement	✓	–	✓	–	✓	2	2	3	2	2
34	Aliza & Sarac, 2025	Haptic VR	Interaction realism	Haptics tend to enhance spatial engagement	✓	✓	✓	–	✓	4	4	4	3	4
35	Kim & Ha, 2021	VR shopping	UX, tangible interaction	Interaction ↑ purchase intention	✓	✓	✓	✓	✓	3	3	3	5	4
36	Lee et al., 2024	VR tutorials	Guidance, presence	Guided VR ↑ completion & replay	✓	✓	✓	✓	✓	5	4	4	5	5
37	Doungtap et al., 2024	VR shopping	NPC, engagement	NPC assistance ↑ engagement & trust	✓	✓	✓	✓	✓	4	4	4	5	4
38	You et al., 2024	Focus VR	Presence, UX	Visual focus ↑ presence	✓	–	✓	–	✓	4	4	4	3	4
39	Zhang & Strobel, 2023	Cross- device VR	Device effect	Device moderates presence & engagement	✓	–	✓	–	✓	4	4	4	3	4
40	Vogt, 2025	Immersi ve learning	Familiarity, device	Experience moderates long-term engagement	✓	–	✓	✓	✓	5	4	4	4	5
41	Tcha- Tokey et al., 2018	VR measure ment	Standard scales	Need for standardized UX metrics	–	–	✓	–	✓	3	4	4	2	3
42	Tcha- Tokey et al., 2017	UX framewo rk	UX constructs	Unified UX model for VR	–	–	✓	–	✓	3	4	4	2	3
43	Schubert & Nedel, 2022	Presence scale	PFS validation	Reliable presence measurement	–	–	✓	–	✓	4	5	4	2	4
44	Agrawal & Han, 2020	Immersi ve UX	Affective engagement	Emotion predicts satisfaction	✓	–	✓	✓	✓	4	4	4	4	4
45	Wong & Li, 2015	VR analytics	Behavior logs	Log data strengthens conversion	–	–	–	✓	✓	3	4	4	2	3

46	Tashjian et al., 2022	Immersive inventor y	Immersive tendency	analysis Trait immersion predicts engagement	–	–	✓	–	✓	4	5	4	2	4
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Quality Scoring Rubric		
Criterion	Scale (1–5)	Description
Study Design (SD)	1–5	Experimental or comparative study design
Data Source Validity (DV)	1–5	Peer-reviewed dataset or field-collected data
Methodological Rigor (MR)	1–5	Clear evaluation, reproducibility
Relevance to RQs (RV)	1–5	Degree of alignment with defined RQs

The bibliographic inclusion matrix summarizes key literature evaluated in relation to RQ1–RQ5, highlighting methodological approaches, dataset utilization, and study quality scores.