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The Relationship between Immersive Learning, Social Presence, and Student Interaction in Technology-Enhanced Learning Environments: A Systematic Literature Review and Bibliometric Analysis (2021-2026)

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Abstract. Immersive technologies (Virtual Reality, Augmented Reality, and Metaverse) are increasingly used as innovative approaches to technology-enhanced learning. However, despite growing research on immersive learning, the ways in which immersive experiences influence social presence and, in turn, student interaction remain insufficiently understood. This study examined the relationship among immersive learning, social presence, and student interaction in technology-enhanced learning environments through a Systematic Literature Review guided by the PRISMA 2020 protocol, combined with bibliometric analysis using VOSviewer. A search of the Scopus database in the 2021-2026 period yielded 38 articles meeting the inclusion criteria. The results showed a rising publication trend led by South Korea, Germany, and the United States, with virtual reality and social presence emerging as central keywords linked to five main research themes. The synthesis indicated that immersive learning was associated with stronger social presence, which in turn supported richer student interaction and collaborative knowledge building, following three conceptual patterns: direct

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relationships, support for collaboration, and mediation of learning engagement. Student interaction itself also reinforced social presence, indicating a reciprocal relationship. The study identified research gaps and proposed a conceptual framework linking the three constructs, suggesting that learning design should deliberately target social presence as the mechanism through which immersive tools translate into meaningful student interaction.

Keywords: immersive learning; social presence; virtual reality; student interaction; bibliometric analysis

1. Introduction

Technology-Enhanced Learning (TEL) has transformed how learning is designed, delivered, and evaluated, driven in part by immersive technologies such as Virtual Reality (VR), Augmented Reality (AR), Mixed Reality (MR), and the Metaverse, which offer three-dimensional, real-time, and realistic visual representations (Baxter & Hainey, 2024; De Luca et al., 2025). Institutions increasingly integrate VR and metaverse into science, engineering, medicine, teacher education, and professional training to boost engagement, motivation, understanding, and higher-order thinking (Schwartz & Blau, 2026; Singh et al., 2024).

However, immersive learning's effectiveness is not determined by technological sophistication alone: improved visual quality and immersion do not translate into effective learning without meaningful social interaction (Schwartz & Blau, 2026). This is consistent with the social constructivist view of learning as knowledge building through interaction (Chadha, 2025). This Reflect a shift from technology-centered research toward understanding how immersive learning facilitates communication, collaboration, and students' social experience (Dunmoye et al., 2024; Molinillo et al., 2018).

One construct central to this social dimension is social presence, the extent to which individuals perceive others as real within a virtual environment, so that communication feels human rather than mediated by a system (Richardson & Swan, 2003). Within the Community of Inquiry (CoI) framework, social presence underlies the development of cognitive and teaching presence through open communication, trust, and group cohesion, and is consistently linked to engagement, satisfaction, and collaboration in online and immersive learning (Huang et al., 2023).

Immersive features such as avatars, spatial representation, synchronous communication, and shared virtual space strengthen social presence by fostering a shared learning environment (Marulanda et al., 2024; Namaziandost & Hwang, 2026), which in turn is closely tied to student interaction in the questioning, discussion, and collaborative problem-solving that build deeper understanding. Environments designed for active communication generate higher interaction than those favoring individual exploration (Guinebert et al., 2018; Terry et al.,

2015), so success should be measured by both immersion level and capacity to facilitate productive interaction.

Empirical evidence supports a positive, reciprocal relationship among the three constructs: immersive experiences are associated with stronger social presence, which encourages open communication and participation (Huang et al., 2023; Maksim et al., 2025; Namaziandost & Hwang, 2026), while frequent interaction in turn strengthens learners' sense of belonging and social presence (Dunmoye et al., 2024; Molinillo et al., 2018; Vuopala et al., 2016). Immersive learning, social presence, and student interaction therefore form a mutually reinforcing system rather than a simple linear relationship.

Nevertheless, those findings were not fully consistent. Some studies reported that higher immersion directly improved interaction (Baxter & Hainey, 2024; Namaziandost & Hwang, 2026), while others found no such gain when designs favor individual exploration or when technical barriers such as cybersickness arose (De Luca et al., 2025; Schwartz & Blau, 2026). Literatures are also conceptually fragmented across educational technology, computer science, and online/computer-mediated communication research, so the three constructs are rarely examined together within one framework.

Previous systematic reviews have examined VR implementation, immersive technology's effectiveness on learning outcomes, or social presence in online learning (Hou et al., 2026; Jia et al., 2026; Monasor-Ortolà et al., 2026). However, few have combined Systematic Literature Review with bibliometric analysis to jointly map publication trends, keyword structure, and the empirical relationships among immersive learning, social presence, and student interaction. This integration is the central novelty of the present study: rather than treating the three constructs separately as prior reviews have done, this study synthesizes quantitative mapping and qualitative evidence synthesis within a single analytical framework to reveal how the constructs interrelate and to identify gaps left unaddressed by single-method reviews.

Based on this gap, this study analyzed the relationship between immersive learning, social presence, and student interaction across primary, secondary, higher education, and other technology-enhanced learning settings through a Systematic Literature Review combined with bibliometric analysis, combining bibliometric mapping of publication trends, institutions, and keyword networks with systematic synthesis of empirical evidence on the mechanisms linking the three constructs.

This study makes three contributions: first, it provides a comprehensive bibliometric map of the field's intellectual structure and development; second, it integrates bibliometric mapping with systematic synthesis to explain the conceptual and empirical relationship among the three constructs; and third, it identifies research gaps and proposes a conceptual framework to guide the design of more effective, collaborative, immersive technology-based learning.

To achieve this goal, this study was designed to answer the following five research questions:

RQ1: What are the publishing trends regarding immersive learning, social presence, and student interaction in technology-enhanced learning environments by year, country, institution, author, and publication source?

RQ2: What are the conceptual relationships among key topics, including virtual reality, social presence, and student interaction, based on keyword co-occurrence analysis using VOSviewer?

RQ3: What are the main research themes that are developing and how are they related?

RQ4: How does empirical evidence from student-based studies in technology-enhanced learning settings explain the relationship between immersive learning, social presence, and student interaction?

RQ5: What research gaps, future research directions, and conceptual frameworks can be formulated based on the synthesis of available literature?

2. Literature Review

2.1 Immersive Learning

Immersive learning is a learning approach that places experience at the core of the learning process by using realistic, interactive, and contextual environments to foster a strong sense of presence during learning (Dengel, 2022; Mystakidis & Lympouridis, 2023). Compared to conventional digital learning, immersive learning enables direct interaction with objects, environments, and other individuals through technologies such as VR, AR, MR, XR, and related visualization technologies (Ursachi et al., 2025; Yadav, 2025). Its implementation can be supported by instructional design model such as ADDIE and informed by theoretical model such as the Cognitive-Affective Model of Immersive Learning (CAMIL) (Mangalagiri et al., 2025; Yan & Omar, 2026).

Research has associated immersive learning with increased engagement, motivation, participation, conceptual understanding, and the development of 21st-century skills, including critical thinking, creativity, and cross-cultural competence (Bicalho et al., 2023; Brunetti et al., 2024; Raju, 2026; Schaffer, 2017; Soelistya et al., 2023; Srishti, 2025; Yan & Omar, 2026). Its application also extends beyond formal education to professional and sustainability training (Onopriienko et al., 2023). However, barriers such as high device costs, limited access, and insufficient long-term evidence remain (Mangalagiri et al., 2025; Msweli & Kgopa, 2025; Onopriienko et al., 2023). Therefore, immersive learning is best understood not simply as a technological solution but as a pedagogical approach that integrates technology, instructional design, and learning experiences (Mystakidis & Lympouridis, 2023; Yadav, 2025).

2.2 Social Presence in a Digital Learning Environment

Social presence refers to students' perception of others as real individuals in a technology-based environment, which supports communication, collaboration, and meaningful learning encompassing emotional expression, belonging, and group cohesion (Esteve-González et al., 2016; Kim, 2025; Pham et al., 2022), and

mediating between teaching and cognitive presence within the Community of Inquiry framework (Mutezo & Maré, 2023).

Social presence is shaped by learning design, platform characteristics, and communication richness, with discussion forums, synchronous communication, and quick feedback generating stronger presence than individually oriented settings (Huang et al., 2023; Krish et al., 2012; Lowenthal, 2017; Maksum et al., 2025; Pham et al., 2022). It is consistently linked to engagement, satisfaction, and learning outcomes (Joksimović et al., 2015; Wu, 2023; Yergaliyeva et al., 2025), while low interaction and limited facilitation remain key barriers requiring deliberate integration of social, pedagogical, and technological design (Coelho & Tedesco, 2017; Lowenthal, 2017; Triberti et al., 2018).

2.3 Relationship between Immersive Learning, Social Presence, and Student Interaction

The relationship between immersive learning and social presence has received increasing attention in technology-enhanced learning research. Conceptually, immersive technologies such as VR, AR, and MR not only enhance the visual quality and interactivity of learning but also create experiences that enable learners to feel genuinely present in a shared learning environment with other users. This condition can strengthen perceptions of social presence, defined as the sense that peers and educators are present as real individuals within a digital environment (Crogman et al., 2025; Varpe et al., 2026).

Thus, immersive technology not only provides an engaging learning experience but also creates opportunities for communication, collaboration, and the development of social relationships in ways that may differ from conventional online learning (Sung & Mayer, 2012; Triberti et al., 2018). This communicative and collaborative space is where student interaction, including questioning, discussion, and joint problem-solving among learners, takes place. Student interaction can therefore be understood as a behavioral manifestation of social presence facilitated by immersive technology.

Greater levels of immersion tend to be associated with stronger social presence: environments that enable avatar-based interaction, shared virtual spaces, and synchronous communication can reduce psychological distance (Pham et al., 2022), while place presence and co-presence can strengthen belonging, collaboration, and satisfaction (Bulu, 2012; C. Zhang & Ziguers, 2009). Social, cultural, and communication design factors further shape students' ability to develop interpersonal relationships within this process (Krish et al., 2012). Although most studies report a positive relationship between immersive learning and social presence, this relationship is not automatic; rather, it depends not only on technological sophistication but also on learning design, opportunities for interaction, and facilitation (Ice et al., 2023).

Environments oriented toward individual exploration tend to produce lower levels of social presence than those designed to support communication and cooperation. These findings highlight that the effectiveness of immersive learning

depends on the integration of technology, pedagogy, and social interaction (Crogman et al., 2025; Triberti et al., 2018; Varpe et al., 2026).

3. Methodology

3.1 Systematic Literature Review and Bibliometric Analysis as a Research

Approach

This study combined two complementary approaches. Systematic Literature Review (SLR) followed systematic, transparent, replicable stages question formulation, search, selection, quality assessment, and synthesis to produce an objective summary of knowledge and reveal research gaps (Barnard, 2015; Garcia & Orsolits, 2025; Schweizer et al., 2016; Turk, 2021). Because rapid publication growth limits SLR's capacity to capture a field's broader structure, this was complemented with bibliometric analysis, applying statistical techniques to bibliographic data (publications, citations, authors, keywords) to identify patterns and knowledge structures (Donthu et al., 2021; Marvi & Foroudi, 2023; Passas, 2024).

Techniques such as citation analysis, co-authorship analysis, and keyword co-occurrence analysis allowed the visualization of relationships between studies and the detection of emerging topics (Chen, 2026; H. Chen et al., 2023; Hallinger & Kovačević, 2022; Kumar, 2025), while bibliometric analysis was comparatively more effective for large-scale publication sets, though it did not evaluate methodological quality (Vaishya et al., 2025).

The two approaches were complementary rather than redundant: bibliometric analysis mapped the research landscape, influential publications, and conceptual structure, while SLR interpreted and synthesized empirical evidence from selected studies (Hallinger & Kovačević, 2022; Hyk et al., 2022; Linnenluecke et al., 2020; Pulsiri & Vatananan-Thesenvitz, 2018). Combining them produced both a quantitative picture of the field's development and an in-depth understanding of theoretical advances, empirical evidence, and future research directions.

3.2 Research Design

This study used the SLR approach which is integrated with bibliometric analysis (Fu et al., 2023; Garcia & Orsolits, 2025; Kaisara & Bwalya, 2023; Li & Mahadi, 2024; Marvi & Foroudi, 2023). This design examined the relationship among the three constructs, using SLR for systematic synthesis and bibliometric analysis to map trends and conceptual structure.

This review followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines for transparency and reproducibility (Salgado Moreno et al., 2024), drawing on Scopus for its broad coverage of reputable publications in education, learning technology, and computer science (Page et al., 2021).

3.3 Review Protocols and Search Strategies

A search protocol ensured that identification, selection, and synthesis of articles followed a systematic, transparent, and replicable process, based on PRISMA 2020 guidelines (Page et al., 2021), ensuring that each stage of the literature search and

screening followed standardized procedures. The search parameters applied in this study are presented in Table 1.

Table 1: SLR Protocol, Search Strategy, and Inclusion/Exclusion Criteria

Parameter / Category	Specification / Inclusion Criteria	Exclusion Criteria
Search Protocol and Bibliometric Tool		
Database	Scopus	
Search date	June 25, 2026	
Search string	TITLE-ABS-KEY (("immersive learning" OR "virtual reality" OR "immersive virtual reality" OR metaverse) AND ("social presence"))	
Search fields	Article titles, abstracts, and author keywords	
Subject area	Entire subject area	
Review protocol	PRISMA 2020	
Bibliometric device	VOSviewer (Version 1.6.20)	
Inclusion and Exclusion Criteria		
Publication range	2021–2026	Published outside the 2021–2026 range
Document type	Scopus-indexed journal articles	Conference proceedings, review articles, editorials, book chapters, notes, and other types of non-article documents
Language	English	Written in a language other than English
Access type	Open Access	Non-Open Access publications
Topic coverage	Examine immersive learning, virtual reality, immersive virtual reality, or metaverse in an educational context	Studies conducted outside the educational context
Main construct	Examining social presence as the main construct or related construct	Studies that did not examine the relationship between immersive learning and social presence
Relevance	Assessed relevant to the research objectives based on the assessment of titles, abstracts, and full texts	Articles that are not relevant to the purpose of the research after an assessment of titles, abstracts, and full texts
Screening Results (PRISMA Flow)		
Initial recordings identified	591	
Recording after document type screening	316	
Recording after language and access filtering	163	
Studies included in the final review	38	

3.4 Data Sources and Search Strategies

The literature search was conducted in the Scopus database because of its broad multidisciplinary coverage, complete metadata, and widespread use in SLR and bibliometric research (Baas et al., 2020; Frandsen et al., 2025; Schotten et al., 2017). Full search parameters are detailed in Table 1, following the PRISMA 2020 guidelines summarized in Figure 1; screening results are detailed in the next subsection.

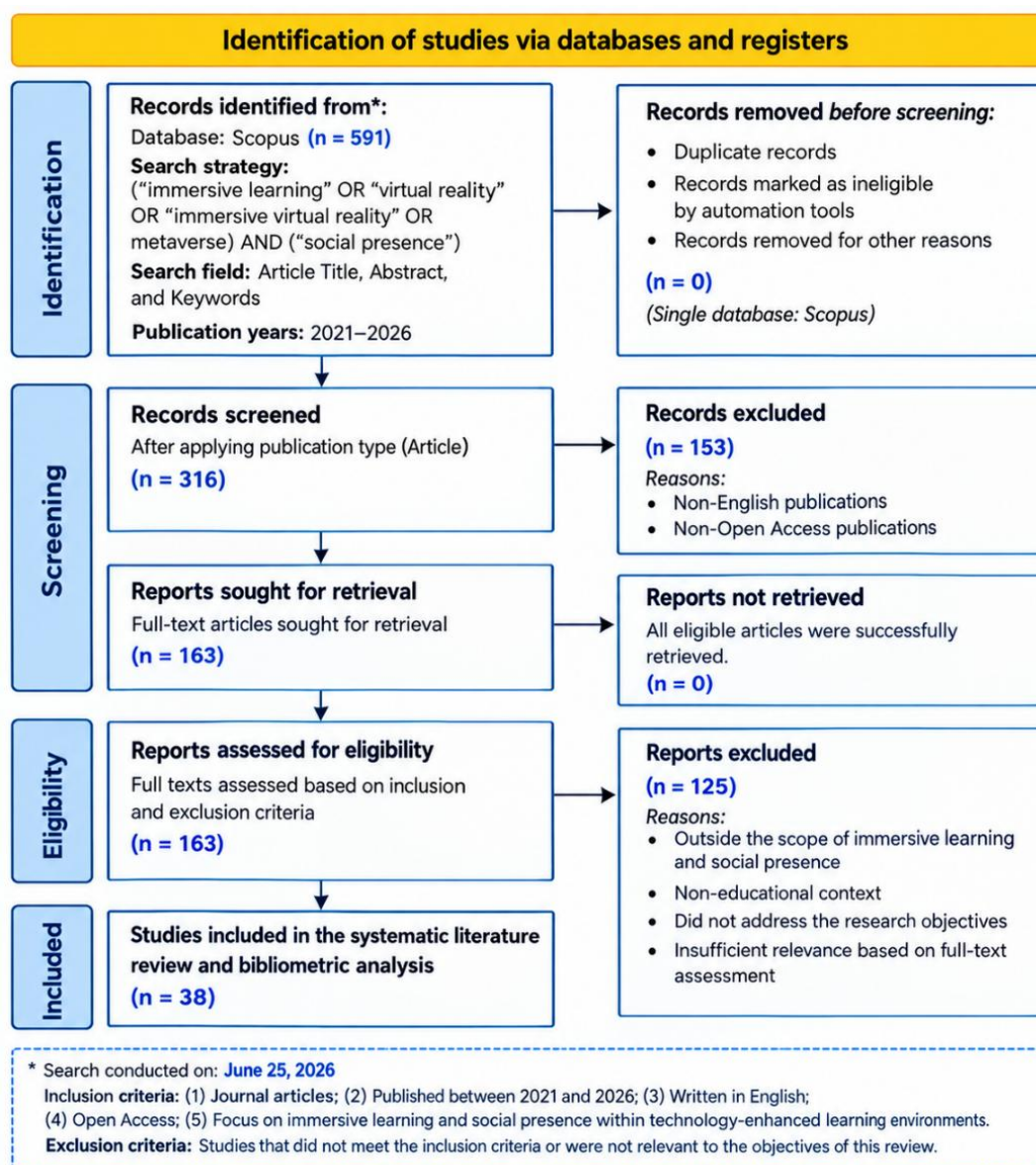


Figure 1: Study Selection Flow Chart Based on PRISMA 2020

3.5 Study Selection and Eligibility Assessment

Following the PRISMA 2020 guidelines, the literature search yielded 591 publications, which were narrowed to 316 after retaining only journal articles, and further to 163 after applying English-language and Open Access criteria. These 163 articles were evaluated against the criteria in Table 1, excluding those outside

the educational context, unrelated to these variables, or lacking relevant empirical evidence. After this eligibility assessment, 38 articles met all inclusion criteria and were used as the data source for the SLR and bibliometric analysis. This process is summarized in Figure 1, with criteria detailed in Table 1.

3.6 Data Extraction and Analysis

Data were systematically extracted from each included study using a standardized form covering author, year, country, educational context, technology used, methodology, participant characteristics, objectives, main findings, and each study's contribution to *immersive learning* and *social presence*. Extracted data were organized for bibliometric analysis and thematic synthesis; full details were available as supplementary material upon request.

Data analysis proceeded through bibliometric analysis and thematic synthesis. Bibliometric analysis used VOSviewer software to explore the intellectual structure and development of research topics related to *immersive learning* and *social presence*. The analysis focused on *keyword co-occurrence* to map conceptual relationships, occurrence patterns, and research clusters, visualized as a *network* to clarify the field's conceptual structure. Furthermore, qualitative thematic synthesis of the 38 selected studies identified key themes, synthesized empirical evidence on *immersive learning*, *social presence*, and *student interaction*, highlighted research gaps, and provided implications for future educational technology research.

4. Results and Findings

4.1 Trends in Publications by Year, Source, Country, Authors, and Institutions (RQ1)

To answer RQ1, the publication characteristics of 38 studies that met the inclusion criteria were analyzed based on the year of publication, source (journal), country of origin, and author and institutional contributions. The distribution of publications by year is shown in Figure 2.

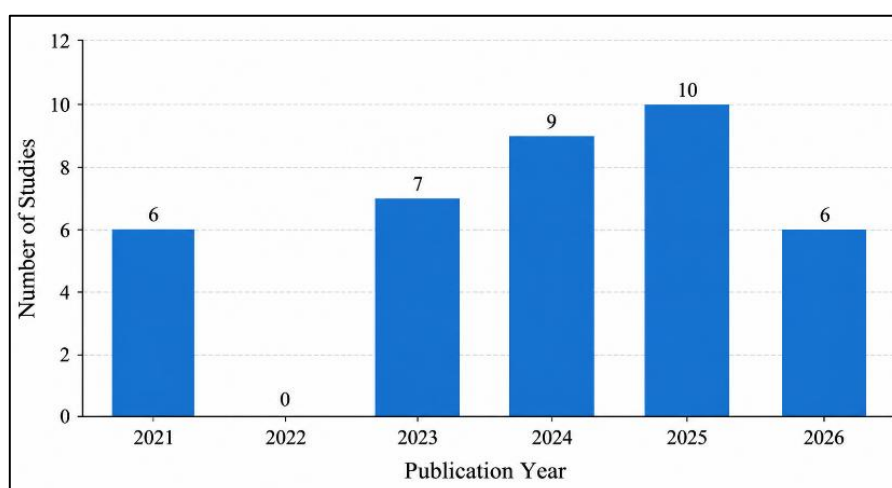


Figure 2: Publication Trends by Year (2021-2026)

The number of publications on *immersive learning* and *social presence* is likely to increase during the 2021–2026 period. In 2021, six articles were found (Lau & Ki, 2021; Lin et al., 2021; Moon et al., 2024). Then no studies met the inclusion criteria in 2022. Since 2023, the number of publications has increased again and reached its peak in 2025 with ten articles (Di Palma et al., 2025; Kadri et al., 2025; Wagner et al., 2025). This reflected growing attention to and adoption of immersive learning technology across educational contexts. For 2026, six articles were identified (Carissoli et al., 2026; Chellappa et al., 2026; Eragamreddy, 2026; Namaziandost & Hwang, 2026). This figure is partial, as the search was conducted on June 25, 2026. Distribution by journal source is presented in Table 2.

Table 2: Distribution of Publications by Source (Journal)

No.	Source (Journal)	Number of Studies
1	Computers and Education: X Reality	5
2	Sustainability (Switzerland)	3
3	Educational Technology Research and Development	2
4	Journal of Computer Assisted Learning	2
5	Applied Sciences (Switzerland)	2
6	Frontiers in Virtual Reality	2
7	Electronics (Switzerland)	2
8	20 other sources	1 each

Computers and Education: X Reality led with five of the 38 studies (13%), consistent with its focus on *Extended Reality* (XR) research and its application in educational contexts. Outside these seven leading journals, publications were spread across 27 journals, with 20 journals contributing only one study each, including educational technology outlets (e.g., *Journal of Computer Assisted Learning*), sustainability journals (e.g., *Sustainability*), and journals in psychology, health, and medicine. This distribution indicates that the research area remains disciplinarily dispersed rather than concentrated in a few specialist outlets.

Table 3: Top 10 Countries by Number of Publications

No.	Country/Region	Number of Documents	Total Link Strength
1	South Korea	9	1
2	Germany	7	4
3	United States	5	4
4	China	4	1
5	The Netherlands	3	1
6	Taiwan	3	1
7	Italy	3	0
8	Austria	2	1
9	Greece	2	1
10	Malaysia	2	0

South Korea led with nine publications, followed by Germany (7) and the United States (5). Although South Korea produced the highest number of publications, the *highest total link strength value* is shared by Germany and the United States,

which each achieved a value of 4, suggesting stronger collaboration and citation connectivity than South Korea, and that publication volume does not necessarily reflect network centrality. *Total link strength* reflects a country's collaborative and citation ties within *immersive learning* and *social presence*.

Table 4: Top Five Authors by Number of Publications (data retrieved June 25, 2026)

No.	Author	Number of Documents	Citation
1	Heller, Jonas	2	19
2	Hilken, Tim	2	19
3	Mahr, Dominik	2	19
4	Di Natale, Anna Flavia	2	7
5	Dunmoye, Isaac D.	2	50

The top five authors each contributed two documents (Di Natale et al., 2020; Dunmoye et al., 2024; Heller et al., 2019; Hilken et al., 2017). But their citation impact varied considerably: Dunmoye, Isaac D. recorded the highest citation count (50), well above Di Natale, Anna Flavia (7), indicating that publication productivity was not necessarily proportional to scientific impact (Carissoli et al., 2026; Di Palma et al., 2025; Dunmoye et al., 2024; Moonen et al., 2024).

Table 5: Top Five Institutions by Number of Publications

No.	Institution (Country)	Number of Documents
1	Centre for Multidisciplinary Research, Anurag University, Hyderabad, India	1
2	Department of Aerospace Engineering, Faculty of Engineering and Technology, Jain (Deemed-to-be University), India	1
3	Department of Computer Science and Engineering, Presidency University, Karnataka, India	1
4	Department of Electrical & Electronics Engineering, Siksha 'O' Anusandhan (Deemed to be University), India	1
5	Department of Physics, Noida International University, Greater Noida, India	1

At the institutional level, the top five institutions are all from India each produced only one document, indicating that contributions remain dispersed across institutions, unlike the more centralized pattern seen at the country level (led by South Korea, Germany, and the United States).

4.2 Keyword Co-occurrence Analysis (RQ2)

To answer RQ2, a keyword *co-occurrence analysis* was carried out using VOSviewer on the author's keywords obtained from 38 selected articles. This analysis identified conceptual relationships between keywords and mapped the topic structure of the research area, visualized in Figure 3.

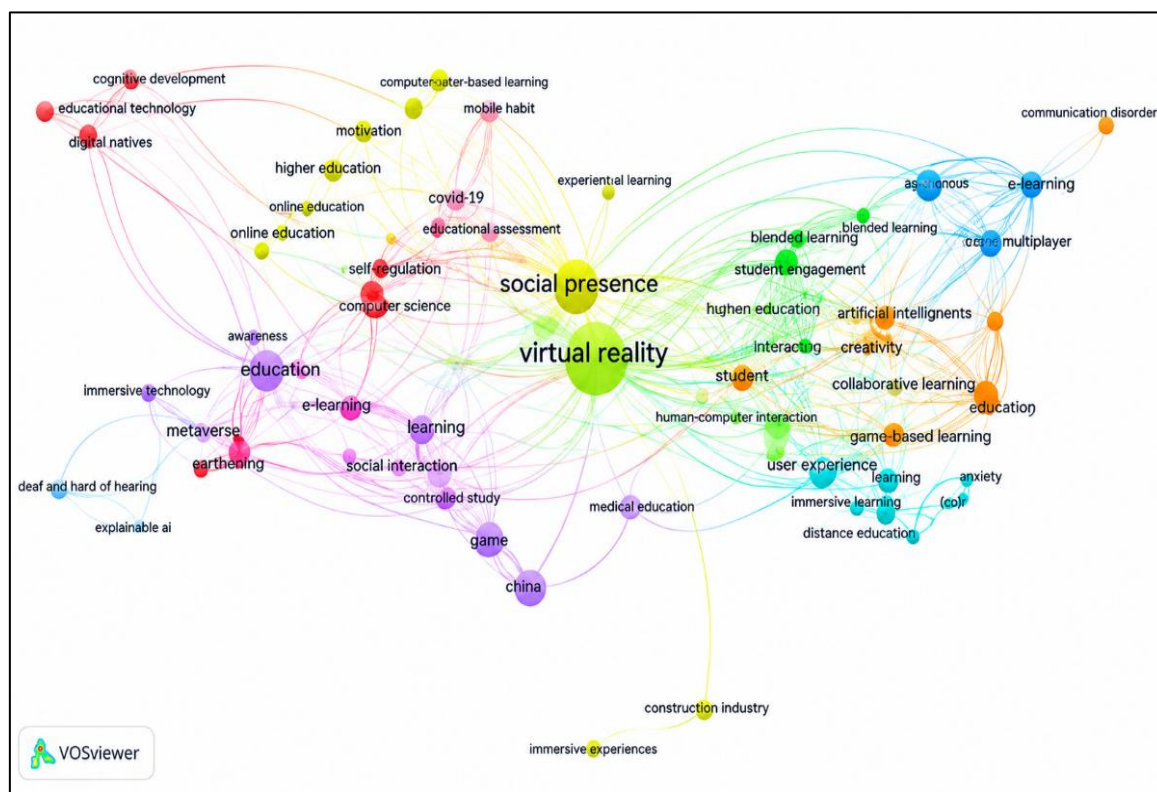


Figure 3: Keyword Co-occurrence Network Visualization

The keyword *co-occurrence* map shows that *virtual reality* and *social presence* are the two most dominant concepts, reflected in their largest node size and higher occurrence frequency, with strong links to other keywords such as *education*, *learning*, *engagement*, the *metaverse*, and *virtual environments*. This pattern of relationship shows that research on *immersive learning* focuses not only on the development of *virtual reality* technology but also on its application to support learning, while *social presence* explains the quality of virtual interaction and engagement.

Table 6: Top 10 Keywords by Occurrence Frequency

No.	Keywords	Frequency of Occurrence	Total Link Strength
1	Virtual Reality	21	70
2	Social Presence	15	45
3	Metaverse	8	20
4	Education	6	23
5	Learning	4	25
6	Virtual Environments	4	24
7	Engagement	3	17
8	Immersive	3	17
9	Student	3	21
10	Students	3	21

Keyword frequency analysis showed *virtual reality* as the most dominant term, appearing 21 times with *total link strength* of 70, indicating that *virtual reality* has a strong conceptual connection to various other topics in the network. These findings indicated that research on *immersive learning* is still dominated by the use of VR technology as a learning medium (Escher et al., 2025; Kadri et al., 2025; Moonen et al., 2024; Wagner et al., 2025). The keyword *social presence* ranks second with 15 appearances and a *total link strength* of 45. This finding indicated that attention extends beyond the technological aspect to the social experiences formed during learning in a virtual environment, where *social presence* supports interaction, engagement, and learning quality (Dunmoye et al., 2024; S. W.-Y. Lee et al., 2023; Namaziandost & Hwang, 2026)

Meanwhile, the *learning* keyword only appeared four times but had a *total link strength* of 25. Despite its low frequency, this high connectivity showed that *learning* functions as a bridging concept connecting more specific terms such as *virtual reality* and *social presence*, to describe aspects of learning, while *learning* served as a concept that overshadows various themes in *immersive learning research* (Carissoli et al., 2026; Lampropoulos, 2025).

4.3 Thematic Pattern of Research (RQ3)

To answer RQ3, the results of the *keyword co-occurrence* analysis were used to identify the main themes in the *immersive learning* and *social presence* research. Based on the pattern of relationships between keywords, several clusters were formed that represented groups of topics with different research focuses. Each cluster was interpreted based on the most dominant keywords, thus providing an overview of the thematic structure that develops in the literature. A summary of the themes in each cluster is presented in Table 7.

Table 7: Main Research Themes Identified from Cluster Analysis

Main Research Themes	Representative Keywords	Cluster
Immersive Technology and Virtual Environments	Virtual Reality, Immersive Learning, Virtual Environments, Metaverse, Augmented Reality, Mixed Reality, 360° Video, Head-Mounted Displays	3, 6, 7, 11, 12, 13, 14
Social Presence and Student Interaction	Social Presence, Social Interaction, Presence, Communication, Cognitive Presence, Community of Inquiry, Avatars	4, 6, 9, 14
Learning Experience and Student Achievement	Learning, Engagement, Motivation, Cognitive Engagement, Academic Performance, Learning Satisfaction, Perceived Learning	1, 5, 8, 10, 15, 17
Educational Context and Pedagogical Application	Education, Higher Education, Online Education, Teaching, Educational Technology, Medical Education, Digital Learning	2, 3, 4, 5, 8, 14, 16
Future Research Trends and Directions	Artificial Intelligence, Explainable AI, Extended Reality, Digital Games, Gamification, Human-Computer Interaction	8, 11, 12

The overlap of certain clusters across multiple themes (e.g., clusters 3, 6, 8, and 14 each appearing in two themes) indicates that these clusters function as conceptual bridges connecting technological, social, and educational dimensions rather than representing isolated topics. The five themes show that research on *immersive learning* and *social presence* develops around five main focuses. These themes included technological aspects related to the development of immersive learning tools and environments, psychosocial aspects that emphasize the role of *social presence* and interaction between students, aspects of learning outcomes that focus on *engagement* and learning outcomes, and implementation aspects that describe the application of immersive technology in various educational contexts.

In addition, themes that reflected the latest technological developments, such as *extended reality* (XR) and *artificial intelligence* (AI), have begun to be integrated to expand the capabilities of immersive learning environments, reflecting a shift toward more holistically understanding how these technologies support learning, social interaction, and effectiveness (Dunmoye et al., 2024; Kasapakis et al., 2023; Moonen et al., 2024; Namaziandost & Hwang, 2026; Wagner et al., 2025).

4.4 Synthesis of Empirical Evidence on the Relationship between Immersive Learning, Social Presence, and Student Interaction (RQ4)

To answer RQ4, thematic synthesis of the 38 included articles produced five main themes describing research on *immersive learning*, *social presence*, and *student interaction* in technology-based learning, showing that research now extends beyond immersive technology as a medium to how it builds *social presence*, increases student interaction and engagement, and influences learning outcomes. Recent studies also explore integrating *extended reality* (XR) and *artificial intelligence* (AI) to create a more adaptive, personalized, and collaborative learning experience.

Overall, this synthesis traces a shift in research focus from immersive technology development, through strengthening learning and social interaction, toward smart technology as a future direction of *immersive learning*. A summary of the five themes and the distribution of articles on each theme is presented in Table 8.

Table 8: Thematic Synthesis of Empirical Evidence (n = 38)

Theme	Focus of Empirical Evidence	Article (s)	Percentage (%)
Immersive Learning Improves Social Presence and Student Interaction	Immersive technologies, including virtual reality, metaverse, and immersive simulations, consistently improve learners' perceptions of social presence, communication, participation, and interaction.	12	31.6
Social Presence Facilitates Collaborative Learning	Social presence encourages collaboration, peer-to-peer communication, teamwork, knowledge sharing, and collaborative problem-solving in a technology-based learning environment.	9	23.7
Social Presence as a Mediation Mechanism	Some studies report that social presence mediates the relationship between immersive learning and learners' engagement, motivation, satisfaction, or behavioral intentions.	6	15.8
Technology Design Shapes Social Presence and Learning Experience	The effectiveness of immersive learning depends on instructional design, avatar realism, interaction quality, communication features, virtual environment design, and usability.	7	18.4
Current Evidence and Future Research Directions	Recent studies emphasize emerging technologies (e.g. metaverse, XR, AI-based learning) and recommend expanding educational contexts, longitudinal research, and stronger empirical validation of social presence.	4	10.5
Total		38	100

The first theme (31.6%, 12 articles) confirms that *immersive learning* strengthens *social presence* and student interaction, improving learners' perceptions of communication, participation, and interaction (Kadri et al., 2025; Wagner et al., 2025). This aligns with earlier bibliometric reviews identifying engagement and social-perceptual outcomes as the dominant focus, though this synthesis extends prior work by explicitly linking these outcomes to student interaction as a distinct construct.

The second theme (23.7%, 9 articles) shows that *social presence* supports communication, cooperation, knowledge sharing, and collaborative learning in a technology-based environment (Lee et al., 2023; Namaziandost & Hwang, 2026).

The third theme (15.8%, 6 articles) shows that *social presence* plays a role as a mediating variable that connects *immersive learning* with various learning outcomes, such as motivation, satisfaction, and *cognitive presence*, reflecting complex interconstruct relationships (Dunmoye et al., 2024).

The fourth theme (18.4%, 7 articles) confirms that the effectiveness of *immersive learning* in building a *social presence* is strongly influenced by the quality of technological design, including the design of virtual environments, communication features, feedback mechanisms, and virtual agent behavior (Di Palma et al., 2025; Sung & Mayer, 2012).

The fifth theme (10.5%, 4 articles) shows research shifting toward integrating of *extended reality* (XR) and *artificial intelligence* (AI) into more diverse, inclusive educational contexts, indicating that *immersive learning research* is increasingly oriented toward adaptive, personalized, intelligence-based learning environments.

4.5 Research Gaps, Future Research Directions, and Conceptual Frameworks (RQ5)

To answer RQ5, synthesis of findings from the 38 included articles identified research gaps, future directions, and conceptual framework elements, summarized in Table 9. Although research in this area has grown rapidly, several aspects still require further attention, as detailed below.

Table 9: Research Gaps, Future Research Directions, and Conceptual Framework Elements

No.	Research Gaps	Future Research Directions	Conceptual Framework Elements
1	Research remains dominated by higher education, with K-12 and diverse learners underrepresented.	Expand <i>immersive learning</i> across educational levels and diverse learners through inclusive designs.	Educational Context & Learner Characteristics
2	The relationship between <i>social presence</i> and learning outcomes varies by technology, task, and context.	Examine moderators such as culture, task type, and learner characteristics.	Moderator Variables
3	Short-term studies with limited samples provide insufficient evidence of long-term effects.	Conduct longitudinal and multi-session studies to assess retention, behavior change, and sustained effects.	Longitudinal Learning Outcomes
4	An integrated framework linking major theories of <i>social presence</i> , engagement, interaction, and learning outcomes remains lacking.	Develop and test an integrated model linking technological and learner factors with learning outcomes.	Integrated Conceptual Framework
5	The effects of emerging technologies, including XR, AI, and intelligent agents, on <i>social presence</i> remain underexplored.	Explore XR, AI, and intelligent agents to support personalized, adaptive, and collaborative learning.	Emerging Technologies

Table 9 reveals, several research gaps emerge. First, research predominantly focuses on higher education, while K-12, vocational, and special needs contexts. Second, the relationship between social presence and learning outcomes remains inconsistent and influenced by technology, design, and context. Third, short-term studies with small samples provide limited evidence on the long-term effects of immersive learning. Fourth, existing theoretical frameworks are generally examined separately rather than integrated into a comprehensive model. Finally, emerging technologies such as XR, AI, intelligent virtual agents, and adaptive learning systems require further empirical investigation regarding their effects on social presence and interaction quality.

Future research should examine immersive learning across diverse contexts using longitudinal and comparative designs, test moderating factors, and develop integrated models linking technological characteristics, learning design, social presence, engagement, interaction, learner characteristics, contextual factors, and cognitive, affective, behavioral outcomes.

5. Discussion

5.1 Discussion of the Main Findings

Overall, the results of the bibliometric review and thematic synthesis showed that *immersive learning* and *social presence* are two closely related constructs in technology-based learning. Their centrality in the keyword *co-occurrence* network and the dominance of related themes across *immersive learning*, *social presence*, and *student interaction*, indicates that research attention has shifted from the development of technology alone to the understanding of how immersive technology can create more meaningful learning experiences through social interaction (Di Palma et al., 2025; Kasapakis et al., 2023; Moonen et al., 2024).

From the perspective of the research landscape, publications are still dominated by countries with relatively high technological capacity, while contributions at the institutional level are still scattered without a truly dominant research center. This reflects a still-developing field, with room for cross-institutional and cross-country collaboration to broaden implementation and diversify research (Lee et al., 2023; Moonen et al., 2024; Zhang, 2025). Notably, all five most productive institutions were based in India, each with a single document, consistent with prior bibliometric work showing that national output can stem from many moderately active institutions rather than a few prolific centers, and one that should be interpreted with caution given the small sample (38 articles) underlying this analysis.

Keyword analysis showed that *virtual reality* and *social presence* are at the core of the conceptual development of this field. The strong connection with the concepts of *learning*, *engagement*, and *education* indicates that research now emphasizes on how these technologies improve interaction, engagement, and learning experience, beyond mere device or platform development. Thus, *social presence* develops into a concept that bridges the relationship between technological characteristics and learning effectiveness (Khojasteh & Won, 2021; Moon et al., 2024; Park & Sohn, 2023).

The thematic synthesis further strengthened these findings by showing that research on *immersive learning* spans technological, psychosocial, outcome, and implementation dimensions, with growing attention to *extended reality* (XR), the metaverse, and artificial intelligence showed that the direction of research is shifting toward more adaptive, intelligent, and personalized learning environments, with technological innovation increasingly viewed as a means rather than an end in itself (Chellappa et al., 2026; Hjeij et al., 2026; Kim, 2025; Streuber et al., 2026). Segmenting the 38 articles into 17 keyword clusters and 5 themes yields relatively fine grained categories, with the smallest theme representing only 4 articles (10.5%); these should be read as indicative tendencies rather than robust categories, pending confirmation on a larger corpus.

Furthermore, the synthesis of empirical evidence showed that the relationship between *immersive learning* and *social presence* operates through multiple mechanisms: it can function as a direct outcome, a prerequisite for collaboration, or a mechanism linking technology to outcomes such as engagement, motivation, satisfaction, and performance indicating that effectiveness depends on learning design and social interaction as much as on immersion level (Çelik & Baturay, 2024; Di Palma et al., 2025; Lau & Ki, 2021; Moon et al., 2024; Park & Sohn, 2023).

5.2 Theoretical Implications

This study's findings, firstly-imply that *immersive learning* is best understood as a learning ecosystem integrating technological characteristics, learning design, and social interaction, rather than merely a means of increasing immersion. Its effectiveness depends less on technological sophistication than on its ability to build a *social presence* that supports communication, collaboration, and student engagement. Thus, *social presence* is an important mechanism that explains how immersive technology produces more meaningful learning experiences (Di Palma et al., 2025; Moonen et al., 2024; Park & Sohn, 2023).

A second implication is the strengthened position of *social presence* as a central construct in technology-based learning. These current results showed that *social presence* emerges not only as an outcome of immersive technology but also as a driver of *student interaction*, engagement, motivation, satisfaction, and learning outcomes. This complexity suggests that research on *immersive learning* needs to view *social presence* as a variable that bridges the relationship between technological characteristics and various learning outcomes (Çelik & Baturay, 2024; Khojasteh & Won, 2021; Moonen et al., 2024).

In addition, this study showed that the relationship between immersive technology and *social presence* is contextual, with virtual environment design, avatar quality, communication features, and learning-activity characteristics all shaping perceptions of *social presence*. This indicates that the success of *immersive learning* depends not only on the level of technological immersion, but also on how the virtual environment is designed to facilitate meaningful interactions (Di Palma et al., 2025; Kasapakis et al., 2023). A further implication is the need for a more integrated conceptual model explaining the relationship between *immersive learning*, *social presence*, *student interaction*, and *learning outcomes*.

Across the reviewed studies, at least five overlapping theoretical lenses were invoked Social Presence Theory, the Community of Inquiry framework, the Technology Acceptance Model, Social Constructivism, and Self-Determination Theory; yet these were typically applied individually rather than integrated, and *social presence* itself was positioned inconsistently across them, appearing variously as an independent variable, a mediator, and a learning outcome. This fragmentation motivates the conceptual framework developed in the next section, which attempts to unify these recurrent relationship patterns (Moonen et al., 2024; Park & Sohn, 2023; Streuber et al., 2026).

5.3. Proposed Conceptual Framework and Future Research Directions

The synthesis of the 38 reviewed studies revealed recurring relationships among immersive technology design, social presence, student interaction, trust, and learning outcomes, though prior studies generally examined these constructs in isolation rather than within an integrated perspective. To address this gap, we propose a conceptual framework synthesized from the most consistent findings across the selected studies not as an empirically validated model, but as a consolidation of the literature's evidence that illustrates potential relationships to guide future empirical research.

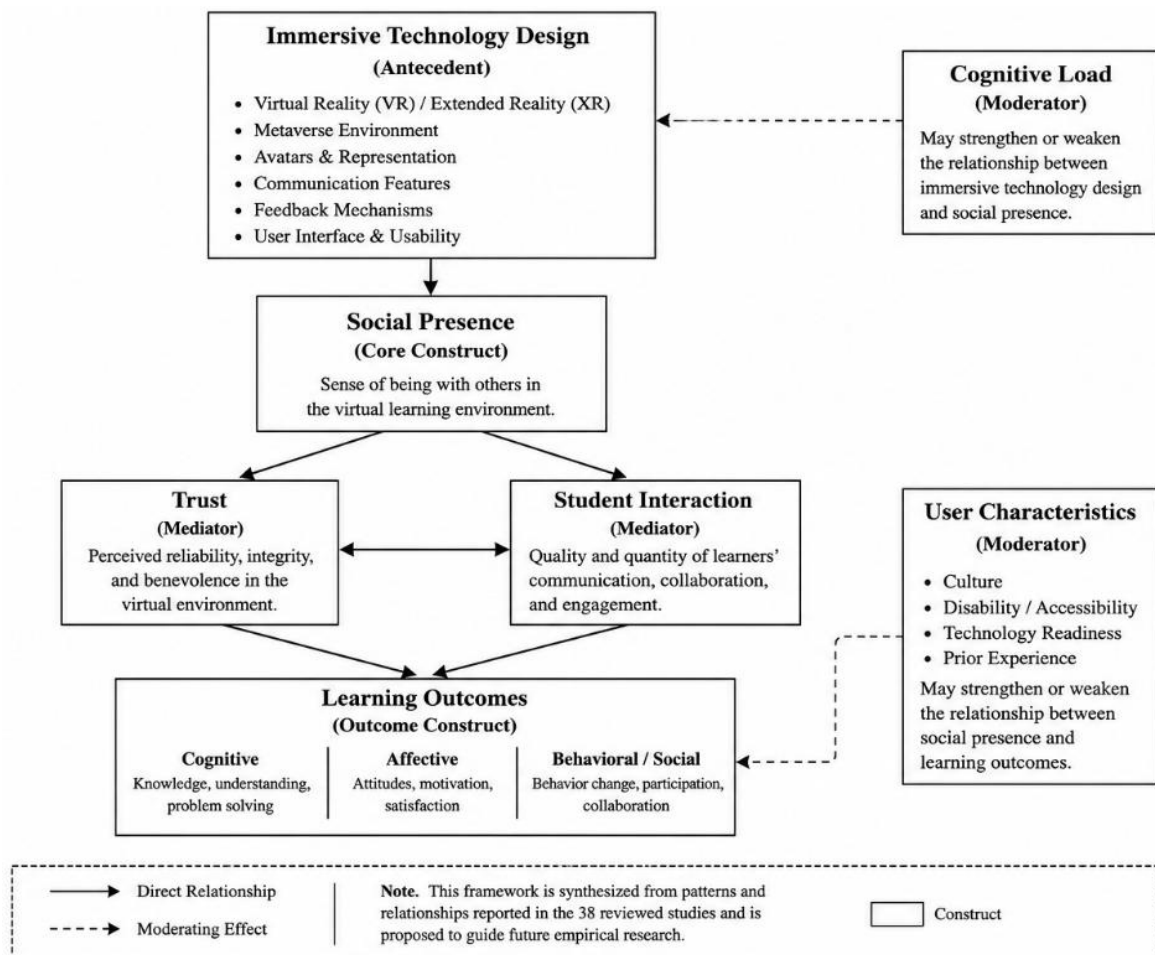


Figure 4: Proposed Conceptual Framework of Immersive Learning, Social Presence, and Student Interaction

As Figure 4 shows, although prior studies extensively discuss the relationship between immersive technology, social presence, and learning outcomes, they tend to examine these separately, leaving unclear how immersive technology's characteristics produce effective learning experiences motivating a conceptual framework integrating the field's recurring constructs into one comprehensive perspective (Kasapakis et al., 2023; Moonen et al., 2024; Park & Sohn, 2023).

Social presence thus functions as a central construct bridging immersive technology design and learning outcomes: technology alone does not automatically improve learning quality, but its positive impact emerges when the environment fosters togetherness, communication, and connectedness among students (Bulu, 2012; De Luca et al., 2025; Huang et al., 2023; Schwartz & Blau, 2026). Thus, social presence is not just a consequence of the use of technology, but is a mechanism that allows technology to produce meaningful learning experiences (Lee & Huang, 2018; Maksum et al., 2025; Wang, 2021).

Within this framework, student interaction functions as the mediating variable that carries the effect of social presence forward into concrete learning behaviors: as learners perceive a stronger sense of social presence, they engage in more active questioning, discussion, and collaborative problem-solving, which in turn reinforces the perception of social presence itself. Figure 4 thus positions student interaction as the mechanism translating social presence into observable engagement and learning gains, not as a parallel outcome.

This relationship is also contextual: cognitive load affects how effectively learners engage with immersive environments, while user characteristics such as technology readiness, prior experience, culture, and accessibility shape how social experiences translate into outcomes, helping explain variation in the literature (Çelik & Baturay, 2024; Kasapakis et al., 2023; Lau & Ki, 2021).

Trust and cognitive load were not systematically evaluated in RQ1–RQ4 and appeared only incidentally in the reviewed studies. Therefore, they are presented in Figure 4 as tentative elements requiring further validation. The framework represents a theoretical integration of consistent relationships in the literature, rather than a verified model, to guide future research on social presence, trust, student interaction, and contextual factors in immersive learning.

6. Conclusion

This study combined a systematic literature review with bibliometric analysis of 38 Scopus-indexed articles on immersive learning and social presence. Regarding to RQ1, publications showed an upward trend since 2021, led by South Korea, Germany, and the United States, with dispersed author/institutional productivity. Referring to RQ2, virtual reality and social presence emerged as strongly connected central concepts. Concerning with RQ3, five main themes were identified, viz. spanning technological, psychosocial, learning-outcome, application-context, and future-direction dimensions.

Relating to RQ4, the synthesis of empirical evidence showed that the relationship among immersive learning, social presence, and student interaction can be understood through three conceptual patterns, namely direct relationships, support for collaboration, and student interaction as a mediating mechanism linking immersive learning experiences to deeper engagement, underscoring that success depends not only on the technology itself but on how its design supports student interaction and social experience. Regarding to RQ5, this study identified five key research gaps and proposed a future research agenda through a conceptual framework that places the Technology Immersion → Social Presence → Learner Interaction/Engagement pathways as the main conceptual mechanisms, with the characteristics of technology design and socio-cultural context as factors that have the potential to moderate these relationships.

Overall, this study maps the intellectual structure of immersive learning and social presence research and offers directions for researchers, educators, and technology developers. While further empirical testing of the proposed framework is needed, this work provides a conceptual basis for understanding how immersive technologies can foster more interactive, social learning experiences.

7. Limitations of the Study

This study has several limitations. First, the literature search was limited to Scopus, which may have excluded relevant studies from other databases. The restriction to English and Open Access publications may also limit the literature coverage. In addition, thematic synthesis used a predefined framework, while involving multiple reviewers could improve consistency. Finally, the small sample of 38 articles and the absence of a formal risk-of-bias assessment mean that the study focused on mapping trends and conceptual relationships rather than evaluating evidence strength through meta-analysis.

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9. Declaration of AI Use

The authors used AI solely for language refinement, word-count reduction, and consistency checking during the manuscript revision process. All AI-generated suggestions were reviewed and verified by the authors. The authors remain fully responsible for the content, accuracy, and interpretations presented in the article.

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