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PAPER

Visualising the Landscape of Immersive Mobile Technologies in English Language Development: A Global Bibliometric Analysis (2020–2025)

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ABSTRACT

Immersion technologies such as virtual reality (VR), augmented reality (AR), and game-based environments have emerged as a transformative approach to young learners' English language development (ELD). This study maps global research on immersive English language development for young learners through a bibliometric analysis of 312 Scopus-indexed publications from 2020 to 2025. Using VOSviewer, co-citation and co-occurrence analyses identified key authors, institutions, journals, clusters, and research hotspots. The results indicate a significant increase in publications following the COVID-19 pandemic. Most research is produced in Asia, particularly in China, while contributions from Africa, Latin America, and the Middle East remain relatively limited. This indicates a significant imbalance in global research. Co-occurrence analysis highlights gaps between technological innovation and human-centered pedagogy, whereas co-citation analysis shows convergence between sociocultural theories and digital pedagogies. The study highlights the need for inclusive immersive learning ecosystems that support Sustainable Development Goal 4 on Quality Education. The paper concludes by suggesting directions for future research on immersive English learning for young learners, particularly in low-resource regions.

KEYWORDS

educational technology, English language development, immersive education, inclusive education, sociocultural theory

1 INTRODUCTION

As a lingua franca for academic, professional, and sociocultural exchange, English proficiency is becoming increasingly important in today's global environment. Thus, it has become a global priority in education to provide learners with strong English language proficiency from a young age [1]. Despite their foundation, traditional language

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teaching approaches often struggle to promote contextualized understanding, intrinsic motivation, and genuine communicative ability. Decontextualized vocabulary lists and grammar drills may be difficult for young learners to understand, especially in non-native English-speaking contexts. This can lead to disengagement and poorer learning outcomes [2]. Immersion education has emerged as a very promising frontier for improving young learners' English language development (ELD), since this ongoing problem has spurred the investigation of novel pedagogical approaches [3].

Immersion education creates rich and contextually meaningful environments where learners encounter and use English in authentic ways. This immersion can take many forms, including pedagogically designed environments such as content and language integrated learning (CLIL), where English is the medium for learning other subjects; game-based learning platforms that embed language acquisition within captivating narratives and challenges; and technology-driven experiences such as virtual reality (VR), augmented reality (AR), and interactive simulations that immerse learners in digitally constructed English-speaking scenarios [4]. By placing young learners in situations where English is required for communication, understanding, and achieving objectives, the language becomes a tool rather than a subject, which may accelerate learning, enhance fluency, and boost confidence [5]. This is the fundamental idea behind situated learning and cognitive engagement.

For young learners' ELD, immersion has considerable theoretical appeal. Proponents argue that by providing understandable input in relevant contexts, it mimics the natural acquisition of a first language, reduces anxiety through engaging and frequently playful interfaces, boosts motivation through internal rewards and new experiences, and facilitates deeper cognitive processing by connecting language to actions and sensory experiences [6]. According to Mohd Barkhaya [7], immersive environments provide dynamic settings that foster cognitive growth in young learners through exploration and interaction. These learners can experiment with language forms, receive rapid feedback, and build pragmatic skills in simulated real-world circumstances. This method has significant potential to foster language proficiency and important 21st-century skills, including teamwork, communication, and digital literacy. Recent reviews from Western contexts further emphasize that immersion benefits must be understood not only as technological affordances but also as cognitive, affective, and sociocultural processes. These works highlight the need for balancing technological novelty with sound pedagogical and developmental principles, particularly when designing immersive environments for young learners.

Even with its increasing acceptance and apparent benefits, empirical data on how immersive education affects young learners' ELD remains complex and requires systematic mapping. While many single studies show improvements in vocabulary acquisition, speaking fluency, listening comprehension, and learner engagement [4], [8], [9], others point to methodological flaws, inconsistent outcomes across various language subskills, or difficulties with implementation fidelity, teacher preparation, technology access, and possible cognitive overload [10]. Important questions remain: For which age groups and learning objectives within ELD do particular immersive modalities (VR, AR, serious games, and CLIL) demonstrate the greatest consistency in efficacy? What are the effects over time? In what ways are effectiveness moderated by variables such as individual learning styles, socioeconomic background, and past knowledge? Researchers and practitioners struggle to maintain a comprehensive understanding of the body of knowledge, prevailing research themes, emerging trends, collaborative networks, and significant knowledge gaps, as the field is constantly evolving and new technologies and applications are continually developing.

Bibliometric analysis then becomes an essential instrument. By examining publication trends, important authors and organizations, citation networks, co-occurring

keywords, and thematic clusters, we can map the intellectual structure and evolution of research on immersive education for young learners' ELD through a quantitative and qualitative analysis of the vast collection of academic publications [11]. This thorough evaluation is crucial for establishing objectives for further study, directing the application of research-based instructional techniques, allocating funds, and ultimately maximizing immersive technology's potential to transform how young learners learn and develop their English proficiency.

2 METHODOLOGY

This study employs a rigorous bibliometric analysis to map, in an organized form, the rapidly evolving and complex research environment regarding the impact of immersive education on young learners' English language development (ELD). A strong, quantitative method for examining vast collections of academic papers, bibliometrics goes beyond conventional literature reviews by impartially determining patterns, trends, and the intellectual framework of a discipline, aligning with (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) PRISMA guidelines [12], [13]. Because it can synthesize large volumes of disparate material, it offers a macroscopic viewpoint that is hard to achieve by hand. According to Bakelak and Rodríguez [14], bibliometrics can reveal the field's growth trajectory, identify key research themes and seminal works, uncover emerging frontiers, highlight influential contributors and collaborative networks, and identify under-explored areas by analyzing publication outputs, citation networks, author/institution collaborations, and keywords [15]. For emerging or dispersed fields, such as immersive education in young learners' ELD, where knowledge consolidation, identification of research gaps, and the evolution of research foci are critical for guiding future studies and real-world applications, this method is especially beneficial [16].

Two complementary techniques – co-citation analysis and co-occurrence analysis – are integral to the fundamental methodological framework of this bibliometric investigation [17]. Citation frequency between two previously published texts is examined through co-citation analysis. According to Pek et al. [18], the scholarly community considers two works to share a major conceptual relationship or belong to the same intellectual basis when they are regularly mentioned together in subsequent studies. This enables us to map the corpus of knowledge in the discipline, identifying groups of seminal or highly significant works that have influenced the field of study. Co-citation analysis within our study, for example, may identify discrete clusters that represent groundbreaking research on (1) the theoretical foundations of language acquisition in immersive contexts; (2) foundational studies on immersive technologies; (3) important studies on language learning and child development; or (4) methodological frameworks for assessing ELD outcomes. VOSviewer may be used to visualize these co-citation networks, allowing us to pinpoint the most important and significant works within each theme cluster. This helps us understand the theoretical underpinnings of the research on immersive education for young learners' English language development.

The Scopus database provides the scholarly publication data necessary to conduct this study. Due to its broad coverage of peer-reviewed literature in the fields of education, technology, social sciences, and languages, its strong reference indexing that facilitates co-citation analysis, and its provision of comprehensive metadata, such as abstracts and author keywords, Scopus was selected [19]. Abstracts, keywords, entire bibliographic entries, and cited references will all be extracted from the data. To create and visualize bibliometric networks, the exported data will be integrated into VOSviewer (version 1.6.20), a specialized software program [20]. The large datasets typical of bibliometric

studies are particularly well-managed by VOSviewer's advanced algorithms and visualization capabilities, which enable the clear mapping and interpretation of co-citation networks (based on cited references) and co-occurrence networks (based on keywords), thereby exposing the conceptual dynamics and intellectual structure of research on immersive education for young learners' English language development.

Several limitations should be acknowledged. First, reliance on Scopus may skew the dataset toward English language publications and Asian universities, underrepresenting scholarship from Africa, Latin America, and the Middle East. Second, the broad keyword approach ("immersive AND English") increases noise in the initial dataset, requiring intensive manual screening to remove irrelevant records. Third, bibliometric mapping provides a descriptive structure but offers limited interpretive depth; therefore, triangulation with thematic analysis is recommended for future work.

2.1 Analysis of inclusion table

A targeted framework for extracting bibliometric data is established by the inclusion criteria listed in Table 1. The PRISMA flowchart notes that the Scopus database uses TITLE-ABS-KEY (immersive AND English) to identify articles where these terms are essential to the study's scope. By limiting the study to 2020–2025, the most recent developments in immersive education technology are captured, demonstrating the field's quick post-pandemic progress. Restricting document types to "Article" ensures analytical rigor by excluding sources such as editorials and conference papers that are not as thoroughly peer reviewed. The English language filter acknowledges certain geographical biases while remaining consistent with the study's focus on ELD, as non-English research on ELD in non-Anglophone contexts may be overlooked. Although the initial 711 records indicate that the keywords "immersive AND English" may be too broad, risking inclusion of irrelevant research, these parameters strike a balance between specificity and feasibility.

Table 1. Inclusion criteria for bibliometric analysis

Scopus Database	ALL
Time period	2020 to 2025
Search field	TITLE-ABS-KEY
Search keywords	"immersive AND English"
Document Type	Article
Language	English

The use of the broad search string ("immersive AND English") represents a deliberate methodological choice to capture pedagogical immersion beyond specific technological labels. However, this approach may have generated a form of conceptual silence by omitting studies that exclusively employ terms such as "virtual reality," "augmented reality," or "mixed reality" without explicitly using the term "immersive." As a result, certain technologically focused studies may be underrepresented, potentially influencing cluster density and thematic emphasis. This limitation affects the representativeness of technology-specific affordances and should be considered when interpreting the dominance of VR-oriented findings. Thus, future bibliometric studies are encouraged to employ layered or parallel search strings to mitigate this limitation.

2.2 Analysis of PRISMA flowchart

To ensure reproducibility and rigor in this bibliometric analysis, the PRISMA flowchart in Figure 1 offers a comprehensive, standardized roadmap of the literature selection process. Using the search string TITLE-ABS-KEY (immersive AND English), 711 records were found in the Scopus database to start the procedure. In an attempt to provide thorough coverage, our initial broad query inadvertently included research beyond the main focus of immersive education for young learners' ELD, such as immersive art or non-educational uses, necessitating further refinement. Two consecutive exclusion filters were used throughout the screening stage.

First, to align the analysis with recent developments in immersive education technology, 150 records released prior to 2020 were excluded. Second, to ensure methodological robustness, 238 non-article records—such as conference papers, book chapters, and editorials—were excluded to prioritize peer-reviewed empirical research. A total of 323 articles were identified using this screening for eligibility evaluation. These 323 items were examined during the eligibility process. To maintain the study's focus on English language growth, eleven non-English publications were excluded. Lastly, 312 studies, or 43.9% of the total dataset, were kept for bibliometric analysis during the inclusion phase. The noise-to-signal ratio present in the original broad keyword search (immersive AND English) is highlighted by this high attrition rate.

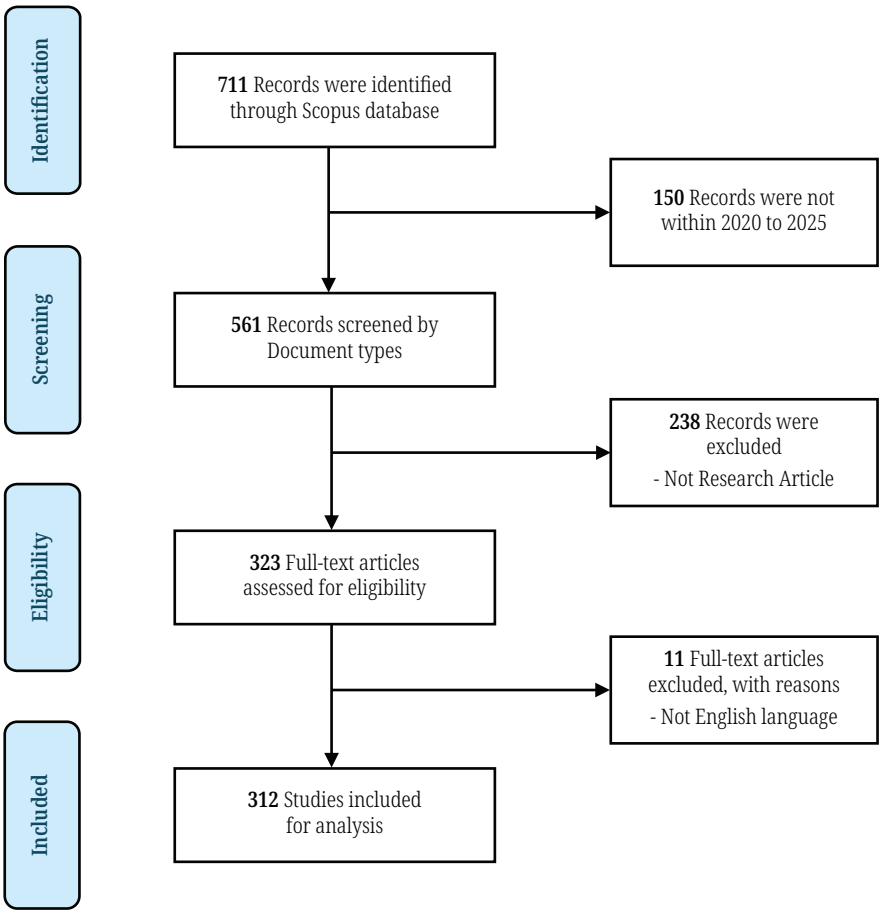

Fig. 1. PRISMA flowchart

This study adheres to the PRISMA 2020 guidelines (see Appendix). The completed PRISMA checklist is provided as a supplementary file to enhance transparency and reproducibility.

3 RESULTS

3.1 Performance analysis

From 2020 to 2025, the Performance Analysis section provides a numerical evaluation of the outputs and impacts of research on immersive education for young learners' ELD. By methodically analyzing bibliometric data along five major dimensions—documents, authors, sources, organizations, and countries—this analysis reveals the field's intellectual footprint, collaboration networks, and historical development. It highlights differences in scholarly involvement while identifying prolific contributors, high-impact journals, prestigious universities, and geographically dominant research clusters. This macro-level viewpoint lays out the groundwork for more in-depth thematic and conceptual investigations in later analyses by providing a fundamental understanding of who drives the conversation, where knowledge is produced, and how the field has evolved.

3.2 Number of documents by year

The field of immersive education for young learners' English language development has experienced revolutionary expansion from 2020 to 2025. From 23 publications in 2020 to a peak of 103 publications in 2024, scholarly output increased at an unparalleled rate of 348% over the course of four years. This trajectory indicates three separate stages of progression. A 109% year-over-year increase in publications (22 to 46) during the first pandemic era (2020–2021) highlighted the urgent need for VR/AR tools amid the worldwide school shutdown. The metaverse investment boom (2022–2024), fueled by institutional ed-tech commitments, then led to a further 94% acceleration (53 to 103 publications). The incorporation of generative AI into immersive language systems has maintained momentum, with 65 publications expected by 2025 based on partial-year data and an annualized output exceeding 120 research papers. Notably, 2024 accounted for 32.7% of the total corpus spanning five years, indicating a shift in the field from exploratory research to widely accepted pedagogical certification.

3.3 Number of documents by source

Disseminating research reveals an interdisciplinary yet fractured knowledge landscape. Frontiers in Psychology comes in second, with 11 papers (3.5%), focusing on the cognitive and motivational aspects of immersion. Education and Information Technologies lead with 14 publications (4.5% of the total output), emphasizing technical implementation frameworks. Niche dominance is evident in specialized journals: *Computer Assisted Language Learning* (four publications) focuses on pedagogical design. In comparison, the *Journal of Computer Assisted Learning* (six publications) emphasizes research in learning analytics. Notably, computer

modeling of language acquisition appears in *Applied Mathematics* and *Nonlinear Sciences* (three papers), demonstrating multidisciplinary spillover. The fact that no single journal accounts for more than 10% of the overall output highlights the conceptual diversity of the discipline while also pointing to a lack of theoretical coherence.

3.4 Number of documents by author

A decentralized and emerging research community is reflected in individual scholarly contributions. With five articles, Lee S. M. stands out as the most prolific author, mainly focusing on VR-assisted vocabulary acquisition in elementary school. Secondary leadership comprises Chan V. (four publications) and Hwang Y. (three publications), both experts in adaptive learning and gamified immersion. The authorship landscape is still somewhat fragmented, though, with only five researchers having at least three publications and 82.3% of authors (257/312) appearing in only one article, suggesting that research programs are not very consistent. Although frequent co-authorships among leading contributors indicate the emergence of academic networks, this dispersion suggests that the area relies on temporary partnerships rather than long-standing research schools.

3.5 Number of documents by affiliation

The output of institutions reveals apparent geographical disparities. The top tier is dominated by Asian universities, with Purdue University in the USA and the Hong Kong Metropolitan University in Hong Kong sharing the top spot, each with six publications. Powerhouses in East Asia closely follow them: National Taiwan Normal University and Kyung Hee University in South Korea, each with five publications, lead the area in innovative immersive pedagogy. The only non-Asian university in the top five is the University of Toronto in Canada, highlighting the continued underrepresentation of Western institutions. Notably, seven of the top ten most productive universities are from Asia, indicating deliberate national investments in instructional technology, whereas European universities are noticeably lacking despite having similar research capabilities.

3.6 Number of documents by country

Asia accounts for the majority of research output, with China providing 86 articles (27.6% of global output), nearly tripling the US contribution of 45 publications (14.4%). East Asian regions are well represented, with Taiwan (24 articles), South Korea (17), and Hong Kong (10 publications) collectively accounting for 16.3% of all research. Leading the way in Western involvement are the United Kingdom (21 publications), Canada (13), and Spain (12). The top 20 producers' total lack of institutions from the Middle East, Latin America, and Africa highlights grave disparities in academic infrastructure and resource distribution, which may skew the field's educational frameworks in favor of technologically developed nations.

3.7 Co-citation analysis

At a threshold of 33, the co-citation analysis identifies the seminal publications that jointly support current studies on immersive education for the ELD of young learners (refer to Table 2). With Alfadil's [21] study on VR-based vocabulary learning emerging as the most significant work (15 citations, link strength 39), these intricately linked references constitute the intellectual core of the area. The prevalence of game-based vocabulary interventions in contemporary research is evident in this dominance, confirming immersive technologies as effective aids for lexical retention. The systematic reviews by Radianti et al. [22] on immersive higher education applications (link strength 23) and by Peixoto et al. [23] on VR in foreign language education (link strength 18) serve as important methodological pillars alongside Alfadil, establishing evidence-based design principles for immersive language environments.

Of particular note is the network's ability to connect modern technology studies with classic theoretical models. Highlighting how zone of proximal development concepts inform scaffolded VR language interactions, the third most co-cited reference is Vygotsky's [24] sociocultural theory (link strength 13). Similarly, despite its pre-digital beginnings, Byram's [25] intercultural competency model remains a conceptual anchor, underscoring ongoing concerns about the cultural aspects of language immersion. Both Cohen's [26] statistical power analysis (link strength 8) and Braun and Clarke's [27] thematic analysis framework (link strength 2) show how researchers rely on tried-and-true qualitative and quantitative methods to assess immersive interventions, demonstrating the coexistence of this theoretical continuity with practical methodological guidelines.

Table 2. Top ten co-citation articles

Rank	Authors	Title	Citations	Total Link Strength
1	[21]	Effectiveness of virtual reality games in foreign language vocabulary acquisition.	15	39
2	[23]	Immersive virtual reality for foreign language education: A PRISMA systematic review.	8	18
3	[24]	Mind in society: Development of higher psychological processes.	8	13
4	[27]	Using thematic analysis in psychology.	8	2
5	[22]	A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda.	7	23
6	[28]	Virtual reality in language learning: A systematic review and implications for research and practice.	6	17
7	[29]	Advantages and challenges associated with augmented reality for education: A systematic review of the literature.	6	9
8	[26]	Statistical Power Analysis for the Behavioral Sciences.	6	8
9	[30]	School engagement: Potential of the concept, state of the evidence.	6	7
10	[25]	Teaching and Assessing Intercultural Communicative Competence.	6	2

3.8 Co-citation analysis by clusters

With an emphasis on how new technologies mediate learning processes, Cluster 1 (see Figure 2) stands for the applied technical edge of immersive language education research. Three interrelated themes unite the eight publications: Mystakidis [31] expands this discussion to metaverse applications, while Akçayır and Akçayır's [29] systematic assessment identifies the pedagogical benefits and implementation obstacles of augmented reality. Concurrently, the theoretical rationale for technological integration is provided by fundamental learning theories, such as the engagement framework developed by Fredricks et al. [30] and the contextual cognition developed by Brown et al. [32]. Xie et al.'s [33] study on mobile VR for oral proficiency and Lin and Lan's [34] historical analysis of VR language environments provide empirical validations. These strands are united by the systematic review by Peixoto et al. [23] and the classroom-reality bridging concept by Wang [35], which together support the use of technology that is pedagogically based and emphasizes cognitive engagement and authentic contextualization. In essence, this cluster charts the shift in language pedagogy from using technology as a tool to using it as an environment.

With a focus on real-world applications and psychological effects, Cluster 2 examines how immersive technologies impact language learning processes. Jensen and Konradsen [36] examine head-mounted displays, whereas Suh and Prophet [37] map the broader immersive technology ecosystem. Hardware and interface issues make up one pillar. Pedagogical implementation strategies are derived from Kessler's [38] forward-looking view of technology-mediated education and Lan's [39], [40] dual frameworks for VR integration in foreign language training. Crucially, York et al.'s [41] assessment of anxiety levels across VR, video, and voice interactions, and Dolgunsöz et al.'s [42] investigation of VR's effect on writing anxiety both highlight the role of emotive components. This cluster, when completed in line with Gadelha's [43] visionary perspective on VR's educational revolution, prioritizes learner needs and accessibility at the forefront of technological deployment. The study emphasizes the importance of paying equal attention to both technical details and psychological safety for successful immersion.

The theoretical underpinnings of immersive language instruction are explained in Cluster 3, which combines traditional sociocultural theories with modern digital extensions. Lave and Wenger's [44] contextual learning theory and Vygotsky's [24] groundbreaking work on social learning serve as the cornerstones, highlighting the co-construction of knowledge in social settings. Byram's [25] model of intercultural competence incorporates an important cultural aspect that is frequently overlooked in tech-oriented research. The case study of VR in advanced Chinese classes by Xie et al. [45] and the systematic review of VR's implications for language learning by Parmaxi [28] are examples of contemporary applications. Lee and Hwang's [46] investigation of metaverse-enabled teacher training, as well as Zhang et al.'s [47] conceptual framework for metaverse education, both demonstrate the cluster's forward-looking perspective. These pieces collectively establish a conversation between disruptive technologies and lasting learning principles, contending that successful immersion must maintain sociocultural authenticity while utilizing digital affordances for experiential learning.

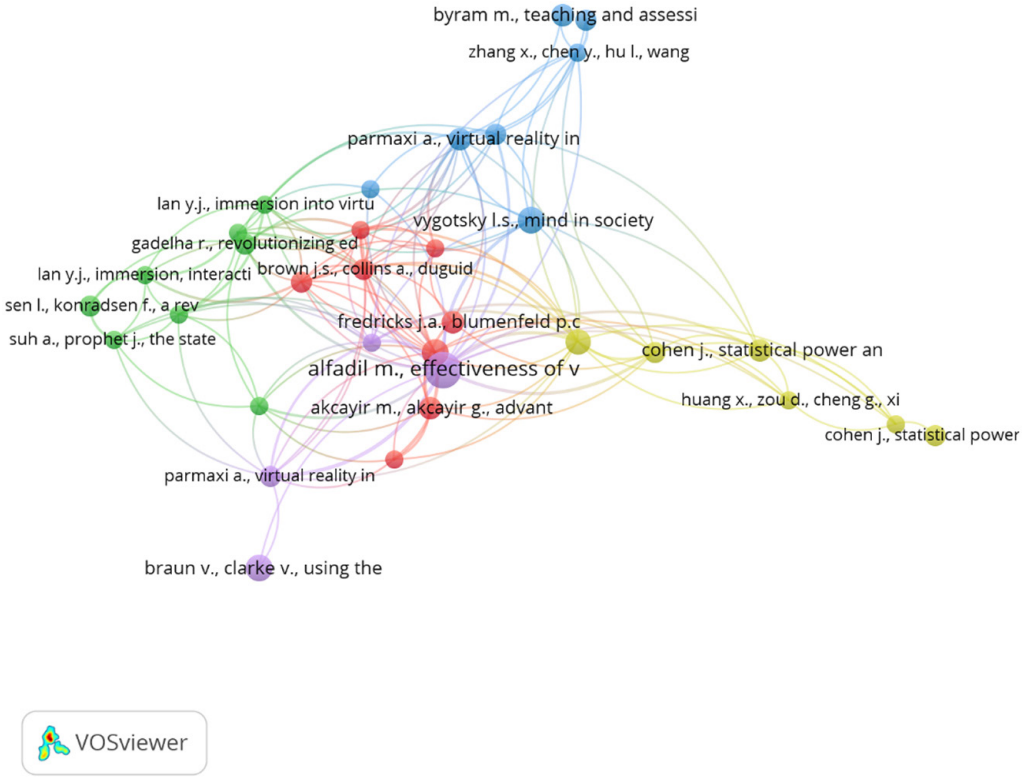

Fig. 2. Co-citation analysis (VOSviewer Visualisation)

Standards for assessing immersive language interventions are established by Cluster 4 (refer to Table 3), which is centered on research quality and result validation. Cohen's [26], [48] statistical power analysis serves as the quantitative foundation for empirical research, and several systematic reviews—Huang et al. [49] on AR/VR language acquisition and Radianti et al. [22] on higher education VR—create evidence-based standards for the field. Targeted empirical studies supplement these: Hsu [50] examines how learning styles mediate AR efficacy, and Chen et al. [51] investigate the effects of VR on vocabulary acquisition and problem-solving. Since technological innovation often surpasses methodological rigor in immersive education research, the cluster's joint focus on producing strong evidence addresses a crucial need. These articles promote standardized metrics by combining statistical frameworks with outcome-focused reviews and empirical validation to evaluate language-learning improvements across various immersive environments.

Table 3. Co-citation analysis by clusters

Cluster No and Colour	Cluster Labels	No. of Articles	Representative Publications
Cluster 1 (Red)	Technological Integration and Learning Engagement	8	[29]; [32]; [30]; [34]; [31]; [23]; [35]; [33]
Cluster 2 (Green)	Immersive Implementation and Affective Dimensions	8	[42]; [43]; [36]; [38]; [39]; [40]; [37]; [41]
Cluster 3 (Blue)	Sociocultural Frameworks and Emerging Paradigms	7	[25]; [44]; [46]; [28]; [24]; [45]; [47]
Cluster 4 (Yellow)	Methodological Rigour and Evidence Synthesis	6	[51]; [26]; [48]; [50]; [49]; [22]

3.9 Co-occurrence analysis

After filtering 1,811 terms with a threshold of 53 occurrences, the co-occurrence analysis (refer to Table 4) reveals the conceptual architecture and research goals of immersive education for the development of young learners' English language skills. Since virtual reality is the primary technological tool for producing immersive language settings, it serves as the field's major anchor (108 occurrences, 341 link strength). The foundational paradigm of technological immersion is established by significant conceptual connections to "immersive" (26 occurrences) and "immersion" (17 occurrences), which further support its centrality. The emergence of augmented reality (15 instances) as a minor but noteworthy node indicates that scholars are recognizing mixed-modality techniques; yet its significantly lesser importance validates VR's current hegemony.

Table 4. The 15 most frequent keywords in the co-occurrence analysis

Rank	Keyword	Occurrences	Total Link Strength
1	Virtual reality	108	341
2	Human	35	221
3	Article	26	183
4	Students	26	151
5	Immersive	26	118
6	Teaching	24	143
7	e-Learning	23	103
8	Humans	21	141
9	Female	17	136
10	Systematic review	17	94
11	Education	17	88
12	Immersion	17	47
13	Metaverse	16	49
14	Language learning	15	42
15	Augmented reality	15	40

Three interrelated thematic strands reveal human-centered qualities that complement this technological foundation. The high-frequency terms "human" (35 occurrences) and "students" (26 occurrences) indicate a continuous emphasis on learner experiences and developmental contexts. In comparison, "female" (17 occurrences) suggests that gender-specific analyses in study designs receive considerable attention. Teaching (24 occurrences) and education (17 occurrences) both demonstrate pedagogical integration, highlighting initiatives to match immersive tools with instructional frameworks. The parallel term "humans" (21 occurrences) underscores the importance of considering cognitive and psychological aspects of a child's development in immersive environments.

Together, these keywords represent a field in technological adolescence: rapidly developing interface capabilities while necessitating a more thorough theoretical understanding of language acquisition processes, fair consideration of learner

diversity beyond gender binary distinctions, and strong pedagogical frameworks to convert immersion into long-lasting language gains.

3.10 Co-occurrence analysis by clusters

Figure 3 shows that integrating emerging technology into educational settings is a key focus, as indicated by 33 keywords in Cluster 1. The terms "metaverse," "augmented reality," "virtual reality," and "artificial intelligence" are used to highlight the field's emphasis on digital immersion platforms as a means of educational innovation. Research emphasizes the alignment of innovative interfaces with educational processes, as evident in the fundamental links between this technology terminology and instructional concepts such as "teaching," "e-learning," and "immersive learning." Although their weaker placing suggests this connection is still developing, the presence of "students" and "language learning" at the cluster's perimeter reveals early attempts to situate technological applications inside learner-centered language acquisition. However, the moderate link strength between "language learning" and core technology terms reveals a persistent gap between tool development and the optimization of linguistic outcomes. The cluster's cohesion, where AI interfaces bridge VR environments and metaverse platforms, signals a research agenda heavily invested in technological convergence.

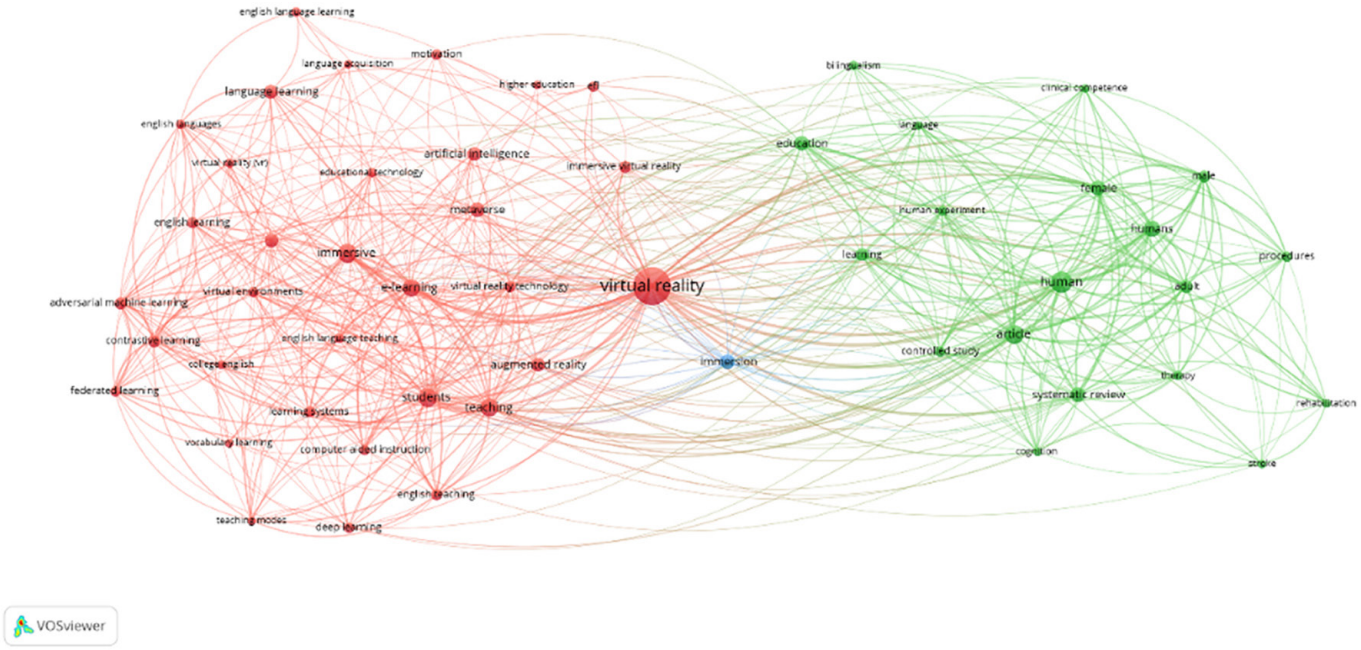

Fig. 3. Co-occurrence analysis (VOSviewer visualization)

Cluster 2, comprising 19 terms (refer to Table 5), emphasizes the methodological and experiential underpinnings of immersive education research. Learner demographics and cognitive processes are given considerable consideration by the core terms "human," "humans," and "female," with "female" particularly denoting gender-aware study approaches. While "systematic review" and "article" highlight the field's growing emphasis on research consolidation and evidence-based practice, the strong co-occurrence of "education" and "learning" anchors pedagogical principles. The fact that "bilingualism" is the only language-specific term in this cluster is noteworthy, as it implies that human-centered studies focus more on multilingual

situations than on monolingual English development. The conceptual gap between the technological core of Cluster 1 ("virtual reality," "AI") and the anthropological focus of this cluster ("human," "female") reveals a crucial split: although technological studies account for the majority of publications, human-dimension research constitutes a separate scholarly subdomain that is concentrated on learner diversity, cognitive impacts, and research quality. This divergence highlights the need for more integrated frameworks that concurrently address technical innovation and human development elements.

Table 5. Co-occurrence analysis of keywords on immersive education

Cluster No and Color	Cluster Label	Number of Keywords	Representative Keywords
Cluster 1 (Red)	Technological Pedagogies in Immersive Language Learning	33	'Virtual reality', 'students', 'immersive', 'teaching', 'immersive learning', 'augmented reality', 'metaverse', 'language learning', 'artificial intelligence', 'e-learning'
Cluster 2 (Green)	Human Dimensions and Evidence Synthesis	19	'human', 'article', 'female', 'humans', 'education', 'learning', 'systematic review', 'bilingualism'

4 DISCUSSION

This bibliometric research identifies a subject that is both conceptually and geographically imbalanced and characterized by high technological acceleration. Strong academic involvement is demonstrated by the remarkable 348% increase in publications between 2020 and 2024, primarily driven by investments in the metaverse and the post-pandemic uptake of ed-tech. However, the 23% year-over-year decline in 2023 indicates that this growth is volatile, suggesting a "hype cycle" pattern where initial exuberance is followed by crucial consolidation. In stark contrast to the dearth of scholarship from Africa and Latin America, the overwhelming concentration of research in Asian contexts – especially China, which accounts for 27.6% – raises questions about the global representativeness of pedagogical frameworks. Co-citation analysis reveals a consistent foundation in sociocultural theories, such as Vygotsky's [24] zone of proximal development, despite the discourse being dominated by technological innovation.

In co-occurrence clusters, this tension takes the following structural form: The "technological pedagogies" of Cluster 1 show little integration with the "human dimensions" of Cluster 2, suggesting that interface creation often occurs without accounting for learner variety. Likewise, the prevalence of systematic reviews (Cluster 2) and fragmented authorship patterns (82.3% of authors only contribute once) points to a subject that is having difficulty converting evidence synthesis into long-term research initiatives. These factors, taken together, present immersive English language development research as a field that is both technologically advanced and pedagogically young, with innovation surpassing both theoretical and practical integration.

The bibliometric clusters identified in this study reveal distinct yet under-integrated technology affordances within immersive English language development research [52]. Cluster 1 reflects interface-driven affordances such as spatial immersion, embodiment, and multimodal interaction, commonly associated with VR, AR, and metaverse-based environments. Cluster 2 foregrounds affective and human-centered

affordances, including anxiety reduction, learner agency, and adaptive feedback, and increasingly supports these features through mobile and AI-assisted systems. Cluster 3 demonstrates theoretical affordances rooted in sociocultural mediation, highlighting how immersive platforms enable situated interaction, collaborative meaning-making, and intercultural engagement. However, the weak interconnections across clusters suggest that technological affordances are often examined independently of linguistic outcomes and developmental processes. Strengthening these linkages remains critical for advancing immersive mobile technologies from experimental tools into pedagogically coherent language learning ecosystems.

The findings intersect with several global digital education frameworks. UNESCO's *Guidelines on the Use of AI in Education* (2023) emphasize ethical, culturally responsive design in an area where immersive ELD research remains unevenly developed. Similarly, the EU *DigComp 2.2* framework emphasizes digital citizenship, accessibility, and inclusive participation, which are currently under-addressed in immersive ELD studies. Strengthening alignment with SDG 4.1 (quality primary education) and SDG 4.5 (reducing educational inequalities) is crucial for ensuring that immersive technologies support equitable learning outcomes for young learners worldwide.

4.1 Theoretical implications

Rethinking theoretical frameworks for immersive language learning is necessary, considering the findings. First, despite the high citations of sociocultural theory, the keyword and co-citation networks reveal a significant gap in the scant attention to language acquisition theories. The underdeveloped links between digital immersion and language acquisition mechanisms are evident in the lack of citations to current SLA models, despite collaborative immersion designs being supported by Vygotsky [24] and Lave and Wenger [44]. Integrated frameworks that specifically connect technology affordances to cognitive processes in second language acquisition are necessary for this.

The co-occurrence cluster divergence, second, shows a misleading division between human and technical aspects. By considering how virtual embodied experiences alter linguistic identity negotiation, models such as "embodied translanguaging," which combine Cluster 2's multilingual and gender considerations with Cluster 1's AI/metaverse focus, should help to bridge this gap in future theorizing. Third, Byram [25] discusses how China's dominance and Euro-American theoretical citations draw attention to Western-centric theoretical underpinnings that are not sufficiently contextualized for Asian learning cultures.

Culturally sensitive models that balance individuality and collectivist pedagogical traditions must be created by theorists. Ultimately, the discipline requires a "techno-sociocognitive" framework that views immersion as a catalyst for reinventing language acquisition itself, rather than merely a delivery method.

4.2 Practical implications

This analysis provides educators, developers, and policymakers with practical avenues to pursue. The significance of institutional support systems is demonstrated for educators by the impressive results achieved by universities such as Purdue University and the Hong Kong Metropolitan University. Training teachers to integrate technology into personalized education should be a top priority for schools. This includes addressing Cluster 2's focus on affective variables like anxiety reduction.

Using co-citation insights, lesson designs should scaffold tasks using Vygotskian principles and incorporate Byram's [25] intercultural frameworks to capitalize on immersion's unique ability to simulate cultures. The dominance of "virtual reality" over "language learning" in search results indicates a misalignment in the market, according to developers. Tools should incorporate evidence-based features, such as feedback mechanisms confirmed by systematic reviews, and prioritize linguistic functionality over technical innovation [22]. Additionally, the weak connections in co-occurrence networks between "AI" and "bilingualism" point to unrealized potential for adaptive multilingual assistance. To alleviate geographic disparities, policymakers must fund infrastructure and research projects in the Global South.

Given the gender imbalance reflected in the keyword "female" and the lack of complementary diversity terms, national curricula should require immersive literacy standards while safeguarding against the potential for technological determinism. The decline in publications in 2023 indicates that practitioners should prioritize long-term deployment over brief trials to guarantee ongoing technological integration that endures past initial hype cycles. When taken together, these actions can turn immersion from discrete technology experiments into fair, language-based learning environments.

Thus, to support system-wide adoption, teacher professional development should be aligned with the immersive technology frameworks recommended by UNESCO and the OECD. Schools should prioritize accessible VR/AR models that function in low-bandwidth contexts to reduce global inequities. Tools should incorporate evidence-based features, such as scaffolding, adaptive feedback, and culturally responsive tasks, to ensure equitable learning gains across diverse populations.

5 CONCLUSION

This bibliometric analysis illuminates the dynamic evolution of research on immersive education for young learners' English language development, capturing a field undergoing rapid upheaval. Scholarly output increased by an astounding 348% between 2020 and 2024, indicating a strong interest in utilizing future technologies as accelerators of pedagogical innovation, such as generative AI and virtual reality. Deep linguistic theorization is typically overshadowed by technological experimentation, and geographic contributions remain mainly concentrated in a few areas. Human aspects of learning are frequently separated from interface development. This expansion reveals these tensions. The academic landscape seeks transdisciplinary cohesion while remaining rooted in timeless sociocultural ideas.

To move forward, three interrelated realms must be purposefully integrated. They redefine immersion as a way for young learners to embody linguistic and cultural information rather than merely a delivery method; theoretical frameworks must first be revised to bridge technological affordances and language acquisition processes explicitly. Research goals should be guided by equitable inclusivity, which includes resolving diversity gaps in learner-focused studies, prioritizing multilingual and culturally responsive designs, and aggressively involving underrepresented regions. Third, pedagogical translation necessitates methodical pathways for transforming empirical discoveries into long-term classroom procedures, guaranteeing that innovations develop into scaffolded, morally sound learning ecosystems rather than isolated experiments.

Immersion education's potential to go beyond conventional language pedagogy through embodied, contextualized experiences is ultimately what makes it promising. Technologists working in tandem with linguists to co-design, scholars from

the Global South forming research agendas, and educators putting evidence-based immersive curricula into practice all need to realize this promise. Such integrative efforts are necessary to harness the field's technological vigor and promote transformative language development, enabling young learners to become culturally adaptable and self-assured communicators in a world that is becoming more interconnected by the day.

6 ETHICAL DECLARATION

The dataset was obtained from the Scopus database on 23 June 2025. The authors conducted data analysis and interpretation. OpenAI's ChatGPT 5.2 was used only to refine sentence structure and improve language clarity in the article. All generated outputs were carefully reviewed, edited, and verified by the authors to ensure accuracy and academic integrity. No generative AI tools were used to create research ideas, conduct data analysis, or draw conclusions. No human participants were involved, and ethical approval was therefore not required. The authors remain fully responsible for the content of this manuscript.

7 REFERENCES

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8 APPENDIX

Appendix (Adapted from Montazeri, A., Mohammadi, S., M. Hesari, P., Ghaemi, M., Riazi, H., & Sheikhi-Mobarakeh, Z. (2023). Preliminary guideline for reporting bibliometric reviews of the biomedical literature (BIBLIO): a minimum requirements. *Systematic reviews*, *12*(1), 239. https://doi.org/10.1186/s13643-023-02410-2)

Section	Item	Checklist Description	Reported in Manuscript
Title	1	Identify the report as a bibliometric/systematic review	Title
Abstract	2	Provide a structured summary	Abstract
Introduction	3	Describe rationale and background	Introduction
Introduction	4	State objectives or research questions	Introduction
Methods	5	Specify inclusion/exclusion criteria	Methodology; Table 1
Methods	6	Identify information sources and date range	Methodology
Methods	7	Provide full search strategy	Methodology; Table 1
Methods	8	Describe screening and selection process	PRISMA Flowchart
Methods	9	Describe data extraction items	Methodology
Methods	10	Describe risk of bias or limitations	Methodological Limitations
Results	11	Describe selection of studies	PRISMA Flowchart
Results	12	Describe study characteristics	Results
Results	13	Describe synthesis methods	Results
Discussion	14	Summarize findings	Discussion
Discussion	15	Discuss limitations	Discussion
Conclusion	16	State conclusions and implications	Conclusion
Other	17	Declare AI usage and ethics	Ethical Declaration

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