Language Related Research
E-ISSN: 2383-0816
https://lrr.modares.ac.ir
https://doi.org/10.29252/LRR.15.5.11

Tarbiat Modares University

Vol. 15, No. 5
pp. 283-311
November & December 2024

Received: 27 March 2023
Received in revised form: 26 May 2023
Accepted: 8 June 2023

Mapping the Semiotic Landscape in Education: Language, Multimodality, and Educational Transformation

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Abstract

This bibliometric analysis explores the integration of semiotics within educational contexts, highlighting a transformative shift towards multifaceted understandings of knowledge construction through language, multimodality, and educational transformation. Drawing on 1823 publications from the Web of Science database, this study employs both co-citation and co-word analysis to reveal prevalent themes and keywords in the field of semiotics in education. The co-citation analysis highlights the evolution of semiotic theories and their application in educational practices, from foundational concepts introduced by pioneers such as Saussure and Peirce to modern interpretations that consider the impact of digital technologies on semiotic resources. Co-word analysis, on the other hand, uncovers key research topics such as multimodality, multiliteracies, and the role of technology in mediating semiotic learning processes. This investigation is novel in its comprehensive approach to mapping the semiotic landscape in education through bibliometric methods, offering insights into how semiotic theories shape educational practices and outcomes, especially in language teaching and learning. By synthesizing findings from diverse research clusters, this study emphasizes the importance of adopting a multidisciplinary approach to understand the dynamic interaction between semiotics, technology, and learning. It contributes to advancing educational research by highlighting the transformative potential of semiotics in crafting more engaging, inclusive, and effective learning environments in the digital era.

***Keywords*:** semiotics, education, language, Saussure, Peirce, multimodality, educational transformation, bibliometric analysis, Web of Science

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[DOI: 10.48311/LRR.15.5.283]

1. Introduction

Semiotics, the study of signs and symbols in communication, is pivotal in education, offering insights into how knowledge is constructed and shared. Beyond verbal and written communication, semiotics encompasses a broad spectrum of signs used in educational environments, from digital platforms to traditional classrooms, making it essential for understanding and enhancing learning processes (Derakhshan, 2024; Innis, 2023; Wanselin et al., 2022). Despite its significance, one significant gap is the limited exploration of how semiotic principles can be systematically integrated into curriculum design and pedagogical strategies. While some studies have touched upon the use of visual and digital symbols in the classroom, comprehensive frameworks for incorporating semiotics into everyday teaching practices remain underdeveloped.

The advent of digital technology has significantly broadened the semiotic resources available, introducing new symbols and altering the usage of existing ones (Derakhshan & Zare, 2023; Lemke, 2013). This expansion necessitates a reevaluation of semiotic applications in education, posing challenges for educators in utilizing an increasingly complex set of communicative tools effectively (Conry et al., 2022). The integration of digital media into educational materials raises questions about their efficacy in supporting learning and critical thinking skills, highlighting the need for educators to adapt to a rapidly evolving digital landscape (Yilmaz, 2021).

This research employs bibliometric analysis to map the semiotics landscape within education, systematically reviewing the wealth of academic literature on the subject. This methodological approach allows for a detailed examination of the field's development, key theories, methodologies, and identification of gaps in the literature. By identifying the most influential authors and publications contributing to semiotics in education, the study will highlight the global scope of this research area. Additionally, the analysis will reveal the predominant research methodologies employed and how they have evolved over time.

This comprehensive approach will uncover underexplored areas and emerging trends that warrant further investigation. It will also provide a foundation for developing targeted research agendas aimed at addressing the identified gaps. Ultimately, this research seeks to enhance the understanding and application of semiotic principles in education, fostering more effective and inclusive learning environments.

By examining the dynamics of academic collaboration and the dissemination of

[DOI: 10.48311/LRR.15.5.283]

ideas, this study will shed light on how knowledge about semiotics in education is generated and shared. The insights gained from this analysis will inform the development of strategic initiatives and policies to better integrate semiotic principles into educational practice, ultimately contributing to the advancement of educational theory and practice.

Research Questions

The aim of this research is to obtain an all-encompassing grasp of the existing literature on the semiotic landscape in education. As such, this study focuses on a bibliometric approach to comprehensively analyze the literature related to the dynamics and trends of the semiotic landscape in education. This study addresses a research gap by providing insights into past, present, and future research areas in the field of semiotics in education. Consequently, the following study objectives are based on the specific bibliometric analysis:

1. To evaluate significant influential past research and current trends on semiotics in education through co-citation analysis.

2. To determine emerging trends of the semiotics in education by using co-word analysis.

2. Literature Review

The discourse on semiotics in education is deeply rooted in the foundational theories of Ferdinand de Saussure and Charles Sanders Peirce. Saussure introduced a structuralist approach with his concepts of the ‘signifier’ and ‘signified,’ emphasizing the arbitrary nature of signs in meaning construction (Saussure, 1983), while Peirce’s triadic model offered a comprehensive understanding of signs, including symbols, icons, and indexes (Peirce, 1960). These frameworks are crucial for exploring how knowledge is constructed and transmitted within educational content and pedagogies.

Research methodologies in educational semiotics vary, including discourse analysis for textual and multimodal data (Derakhshan & Shakki, 2020; Kress, 2011), and ethnographic studies highlighting the impact of cultural signs in learning (Kendal, 2011). Studies range across educational levels, focusing on classroom semiotics and the transformative role of digital media in education (Godhe & Magnusson, 2017). Recent critiques call for examining power dynamics and inequalities through semiotics, urging the field to address societal norms and hierarchies (Kress, 2013).

[DOI: 10.48311/LRR.15.5.283]

As digital literacy becomes increasingly crucial, future semiotic research must embrace the challenges and opportunities presented by emerging technologies like artificial intelligence and virtual reality (Barricelli et al., 2016). This bibliometric study aims to synthesize the extensive literature on educational semiotics, drawing on varied research to outline past, present, and prospective directions of semiotics in education. By employing bibliometric methodologies, this analysis seeks to distill insights from the broad spectrum of semiotic research, contributing to the field's ongoing evolution and the enhancement of educational practices (Ellegaard, 2018).

3. Methodology

3.1. Bibliometric Approach

Bibliometric research is a quantitative analysis of scientific literature that evaluates and assesses the impact of scholarly publications (Almas et al., 2022). Utilizing statistical methods to analyze various aspects of research output, including the number of publications, citations, and patterns of collaboration, among others. In specific research domains, bibliometric research can help identify trends, influential works, and emerging topics (Wang, 2018). Bibliometric research, including co-citation analysis and co-word analysis, can be a valuable instrument for assessing and comprehending the evolution of research fields and identifying potential growth areas or future directions within a given domain (Tan Luc et al., 2022).

Co-citation analysis is predicated on the assumption that if two documents are frequently cited together, their contents are likely to be related (Trujillo & Long, 2018). This technique can be used to identify the most influential publications and authors in a research field and to reveal the structure of the scientific literature in a particular domain. On the other hand, co-word analysis focuses on the co-occurrence of keywords in scientific publications. By identifying frequently co-occurring terms, it can reveal the dominant themes and relationships within a particular research field (Verma et al., 2024). In addition, it can predict the future trajectory of a research field, providing a glimpse of its evolution (Wider et al., 2023). Thus, co-word analysis can be used to evaluate the past, present, and future trends of a given topic.

3.2. Search String

Table 1 details the search terms employed in this bibliometric study. The topic search

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(TS) function of the Web of Science (WOS) database was utilized to restrict search terms to titles, abstracts, and keywords. The search terms covered articles published between 1975 and 2024. The search began on March 13, 2024. The WOS database is well-known for its high quality and comprehensiveness, making it an excellent choice for bibliometric research (Pranckutė, 2021). It is the world's most widely used, and most reliable research publication and citation database, providing comprehensive coverage of the world's leading research (Li et al., 2018). Table 1 shows the inclusion and exclusion criteria for this review. Based on these criteria, 1823 articles were retained in the screening process.

Table 1

Search String, Inclusion, and Exclusion Criteria

WoS Database	ALL
Time Period	Up to March 2024
Search field	TOPIC
Search keywords	"Semiotic*" AND ("Education" OR "Teaching" OR "Learning")
Citation Topics Meso	ALL
Document Type	Article
Languages	English

4. Results and Discussion

The WOS database yielded 18,609 citations for the chosen articles (N = 1823), 1299 of which were self-citations. The H-index was 58, and the average number of citations per article was 10.21. The 1823 articles demonstrate a growing interest in the semiotics in education research. The first publication appeared in 1975. Although the number of journal publications fluctuates annually, there is an overall upward trend. Prior to 2007, The growth in the number of journal publications is slow. However, the volume of publications increased exponentially from 26 in 2008 to 231 in 2022, representing a significant percentage increase within fourteen years. Although the number of journal publications slightly declined from 2022 to 2023, the number published in 2024 is expected to remain high. Figure 1 depicts the number of articles published and citations received from 1975 to 2024.

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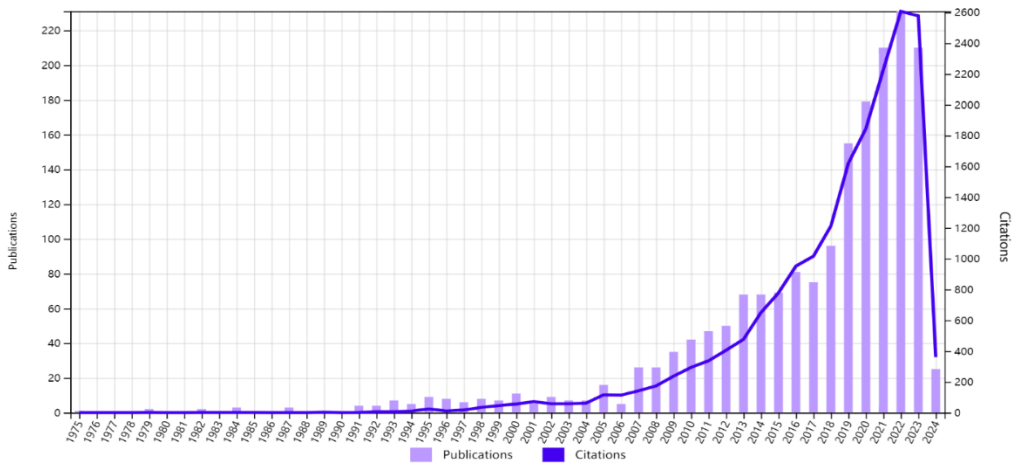
Figure 1

Number of Publications and Citations Between 1975 and 2024



4.1. Co-citation Analysis

For the co-citation analysis, the citation threshold was set at 59, resulting in a total of 26 cited references. Figure 2 depicts a network analysis derived from the sources cited. The top ten co-cited references with the strongest total link strength are displayed in Table 2. Kress (2011) was cited 189 times, while Halliday (1978) was cited 144 times, and Kress & Van Leeuwen (2020) was cited 156 times. The analysis of co-citations reveals 4 distinct clusters, each with a particular theme to it. These clusters represent groups of publications that are related and share a common theme. Similar publications are organized within the same cluster, which is represented by nodes of the same color (Dong et al., 2023). Following is a description of each cluster and its respective label:

Cluster 1's 17 publications delve into "**The Multimodal Literacy Paradigm"**, highlighting a pivotal shift in educational paradigms to embrace diverse communication forms—visual, auditory, digital, and textual. This shift mirrors the digital age's call for a broad communication toolkit, underscoring the importance of multimodality in education (Baldry & Thibault, 2006). Foundational contributions by Hodge and Kress (1988), along with Kress and Van Leeuwen's (2020) work, stress the critical engagement with multimodal texts. The multiliteracies pedagogy, proposed by Cazden et al. (1996), champions educational practices that recognize cultural, linguistic, and technological diversities, equipping students for future challenges. This idea is expanded by Cope and Kalantzis (2005) to highlight

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literacy's role in critical and transformative learning, while Gee (2007) addresses the social linguistics and literacies' ideological aspects within education. Furthermore, Jewitt et al. (2016) argue that curricula and assessments reflect multimodal communication's complexity. Kress and Van Leeuwen (2020) provide a visual design grammar, crucial for visual communication navigation, with Kress (2003, 2011) exploring new media age literacy. A significant part of this exploration includes understanding the cultural content presented in educational materials, as discussed by Wang and Hemchua (2022). Their research on the semiotic interpretation of cultural representations in EFL textbooks underscores the critical role of images in shaping learners' cultural perceptions and language acquisition. Elements like learner optimism and resilience can be pivotal in enhancing language proficiency and overall student engagement, which not only address the signs and meanings in educational content but also consider the learner's psychological environment as part of the semiotic landscape (Derakhshan, 2022). This collective body of work pushes for a transition towards multimodality in education, preparing students for a world that is digitally enriched, visually complex, and culturally diverse, thus redefining literacy and communication in educational settings and fostering more inclusive, engaging learning environments.

Cluster 2, encompassing 15 publications, highlights the intricate blend of semiotics and embodied cognition in educational research, introducing an enriched understanding of learning through interactions with symbols, environments, and bodily experiences under the "**Interdisciplinary Perspectives on Education"** theme. This narrative commences with Gibson's (1979) ecological perspective on visual perception, providing insights into learners' environmental interactions, crucial for educational settings where semiotic resource interpretation is fundamental. Seamlessly merging with Vygotsky's (1986, 2012, 1978) cognitive development theories, it emphasizes social mediation's role via language and symbols, intertwining environmental and sociocultural cognitive dynamics. Bakhtin's (1981) concept of the chronotype, alongside Eco's (1979) semiotics theory, deepens this discourse, exploring the significance of signs in communication and learning as inherently semiotic activities. Applied to fields like mathematics education (Duval, 2006; Godino et al., 2007), these frameworks expose semiotic complexities in learning, advocating for pedagogical approaches that consider educational content's semiotic richness. Further, discussions by Goodwin (2000), McNeill (1992), and Radford (2003) on the role of gestures and physical actions in meaning-making highlight the

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symbiosis of embodied cognition and semiotic processes. Lakoff and Johnson's (2008) investigation into metaphors and Lave and Wenger's (1991) and Wertsch's (1991) work on situated learning and mediated action underscore learning as an active, contextually influenced endeavor. Collectively, this scholarship advocates for educational practices that integrate semiotics and embodied cognition, promoting a paradigm shift towards more holistic and nuanced educational approaches.

Cluster 3 (blue) contains 15 publications on the topic of "**Translanguaging: Redefining Language Education**". The collective body of research signals a significant shift in linguistic and educational paradigms towards translanguaging, moving beyond traditional, structuralist perspectives on language learning to address the complex realities of multilingual societies. Blommaert (2010) sets the stage with his sociolinguistic analysis in a globalized context, advocating for approaches like translanguaging that bridge linguistic divides. Canagarajah (2018) further challenges conventional language paradigms by introducing spatial repertoires and the contextual application of language. Flores and Rosa (2015), along with Flores and García (2013), critique existing raciolinguistic ideologies, proposing the creation of spaces that recognize the fluidity of language practices across bilingual spectrums. García et al. (2009, 2014) highlight the pivotal role of translanguaging in valuing emergent bilinguals and urging educational systems to adapt to learner diversity. Supported by dialogism and semiotic theories from Holquist and Emerson (1981) and Jefferson (2004), the framework advocates for a dialogical, context-specific understanding of language. Lin (2019), Otheguy et al. (2015), and Pennycook (2017) link translanguaging to broader semiotic processes, emphasizing its capacity to promote inclusivity in language education. Van Lier (2004) and Wei (2011, 2018) present translanguaging as both a practical and theoretical approach, essential for constructing identities and facilitating genuine communication. This convergence of research portrays translanguaging as a dynamic, integrative framework essential for navigating the linguistic intricacies of globalized societies, pushing for a more inclusive and reflective approach to language education and communication.

Cluster 4 (yellow) contains 12 publications titled "**Reframing Education Through Multimodality and Semiotics**". These publications trace the evolution of multimodal and social semiotic frameworks in education, grounding their exploration in the foundational theories of Halliday, who, through works like "Cohesion in English" (1976) and "Language as Social Semiotic" (1978), laid the theoretical bedrock for understanding language's multifunctional roles. Building on this,

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Matthiessen's "Introduction to Functional Grammar" (2014) and Martin and Halliday's "Writing Science" (1993) delve deeper into how language structures facilitate diverse educational discourses, particularly in science. Bezemer and Kress (2008) extend these concepts to writing and multimodal texts, emphasizing designs for learning that incorporate visual and other semiotic modes alongside traditional text. This approach is enriched by Kress and Van Leeuwen's (2020) work on the grammar of visual design and Lemke's (1990) "Talking Science," which collectively underscore the significance of multimodal communication in constructing knowledge in science education. Kress et al. (2006) and Tang, Delgado, and Moje (2014) further elaborate on the practical applications of these theories, presenting frameworks for multimodal teaching and learning and the analysis of multimodal representations in science education. Together, these works advocate for a broadened understanding of literacy and communication in educational settings, recognizing the integral role of various semiotic resources in facilitating comprehensive and inclusive learning experiences. This integrated narrative highlights the progression from linguistic analysis to a richer, multimodal semiotic understanding of learning, emphasizing the need for educational practices that embrace the full spectrum of communicative forms.

Table 2

Top 10 Documents in Terms of Co-citation and Total Link Strength

No.	Documents	Citation	Total link strength
1	Kress, G. (2011). Discourse analysis and education: A multimodal social semiotic approach. In *An introduction to critical discourse analysis in education* (pp. 205-226). Routledge.	189	692
2	Halliday, M. A. K. (1978). Language as social semiotic: The social interpretation of language and meaning. London: Edward Arnold, 1978. Pp. 256. *Language in Society*. 1980; 9(1):84-89.	144	546
3	Kress, G., & Van Leeuwen, T. (2020). *Reading images: The grammar of visual design*. Routledge.	156	420
4	Cazden, C., Cope, B., Fairclough, N., Gee, J., Kalantzis, M., Kress, G., ... & Nakata, M. (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard educational review*, *66*(1), 60-92.	98	348
5	Van Leeuwen, T. (2005). *Introducing social semiotics*. Psychology Press.	93	336
6	Kress, G., Charalampos, T., Jewitt, C., & Ogborn, J. (2006). *Multimodal teaching and learning: The rhetorics of the science classroom*. Bloomsbury publishing.	68	305

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No.	Documents	Citation	Total link strength
No.	Documents	Citation	Total link strength
7	Jewitt, C. (2003). Re-thinking assessment: Multimodality, literacy and computer-mediated learning. *Assessment in education: Principles, policy & practice*, *10*(1), 83-102.	72	298
8	Jewitt, C. (2008). Multimodality and literacy in school classrooms. *Review of research in education*, *32*(1), 241-267.	58	292
9	Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard University Press.	108	272
10	Halliday, M. A. K., & Matthiessen, C. M. (2013). *Halliday's introduction to functional grammar*. Routledge.	66	258

Note. Author interpretation based on VOSviewer analysis

Figure 2

Co-citation Analysis of Semiotics in Education

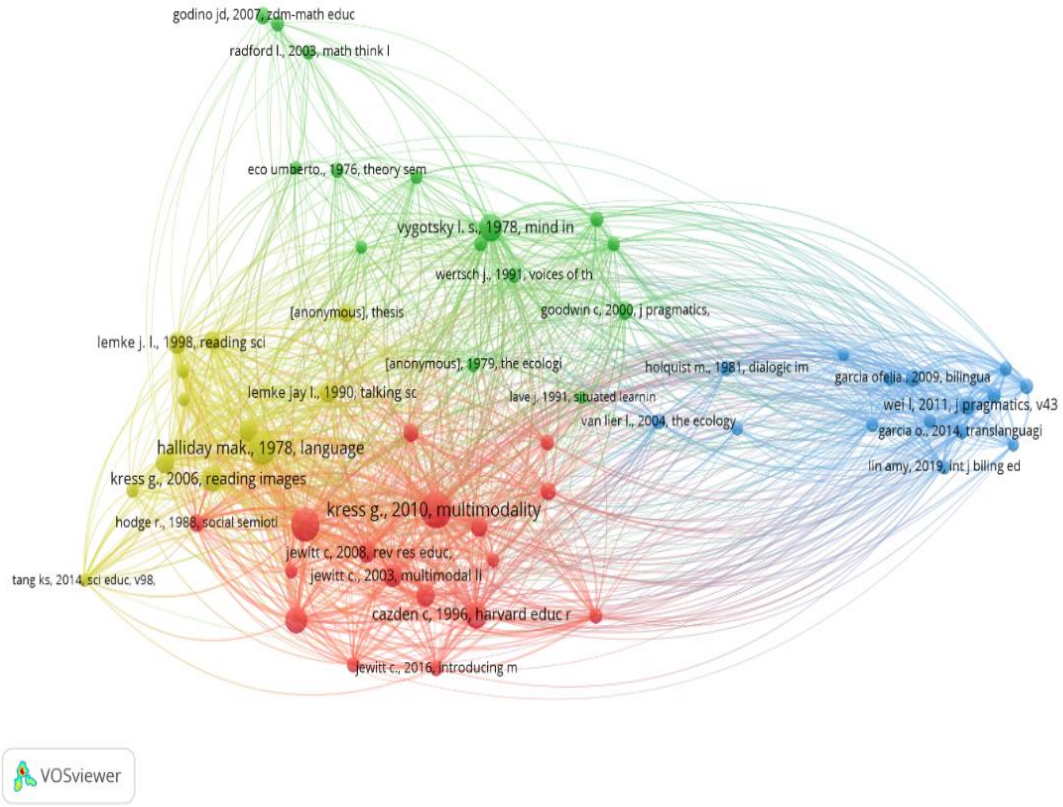

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Table 3
Co-citation Clusters of the Semiotics in Education

Cluster	Cluster label	Number of publications	Representative publications
1 (red)	The Multimodal Literacy Paradigm	17	Baldry & Thibault (2006); Cazden et al. (1996); Cope & Kalantzis (2005); Gee (2007); Hodge & Kress (1988); Jewitt (2008, 2003); Jewitt et al. (2016); Kress & Van Leeuwen (2020, 2002); Kress et al. (1997); Kress (2003, 2011); Bezemer & Kress (2015); Norris (2004); Van Leeuwen (2005).
2 (Green)	Semiotics and Embodiment in Education	15	Gibson (1979); Vygotsky (1986, 2012, & Cole 1978); Bakhtin (1981); Duval (2006); Eco (1979); Godino et al. (2007); Goodwin (2000); Lakoff & Johnson (2008); Lave & Wenger (1991); McNeill (1992); Radford (2003); Wertsch (1991).
3 (Blue)	Translanguaging: Redefining Language Education	15	Blommaert (2010); Canagarajah (2018); Flores & Rosa (2015); Flores & García (2013); García et al. (2014); García (2009); Holquist & Emerson (1981); Jefferson (2004); Li & Pang (2018); Lin (2019); Otheguy et al. (2015); Pennycook (2017); van Lier (2004); Wei (2011, 2018).
4 (Yellow)	Reframing Education Through Multimodality and Semiotics	12	Bezemer & Kress (2008); Halliday & Hasan (1976); Matthiessen (2014); Martin et al. (1993); Halliday (1978); Halliday & Matthiessen (2013); Kress et al. (2006); Kress & Van Leeuwen (2020); Martin & Veel (1998); Lemke (1990); Tang et al. (2014).

Note. Author's interpretation derived from VOSviewer analysis

4.2. Co-occurrence of keyword

There were at least 20 occurrences of each of the 55 keywords discovered. According to the co-word analysis, the most frequently used keyword was "semiotics" (230 occurrences), followed by "education" (188 occurrences) and "language" (168 occurrences). Table 4 displays the top 15 co-occurred keywords within this study domain. Figure 3 illustrate the network structure of the keyword co-occurrence. The diagram depicts five distinct clusters that appear to be related. Each cluster was examined and discussed as follows:

Cluster 1 (Red): This cluster contains 15 keywords. This cluster's keyword

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revolves around the central theme of "**Semiotics in Multilingual Education Evolution**". The discourse in educational semiotics is increasingly focusing on the nexus of language, identity, and politics within multilingual classrooms, particularly in higher education. This evolving conversation explores how agency and identity shape educational paths in diverse settings (Humphrey, 2020), emphasizing the role of power dynamics and language negotiation between students and educators (Rodriguez, 2013). Discourse analysis has become crucial in dissecting how language forms the foundation of knowledge and authority in academic contexts. The influence of social media on identity formation is under scrutiny for its significant impact on educational dynamics (Miller, 2017), with platforms becoming key sites for identity negotiation and influencing broader discourse (Fox & Bird, 2017). The trend towards embracing multilingualism and translanguaging approaches highlights a move towards more inclusive education, addressing the complex interplay of language and race (Wei & Lin, 2019). Moreover, the role of social media is expanding to critique traditional educational models and promote critical content engagement (KhosraviNik & Unger, 2016). This trajectory suggests future research will further investigate the impact of discourse and identity on educational frameworks, emphasizing the need for semiotic understanding to foster equitable educational practices in diverse learning environments.

Cluster 2 (green): This cluster has 14 keywords that can be grouped together under the broad theme of "**Semiotics and Learning in Digital Age**". The convergence of keywords such as children, communication, culture, embodiment, gestures, learning, media, and technology marks a notable shift towards integrating semiotics and learning in the digital era. This shift indicates a growing comprehension of how learners, particularly children, utilize embodied gestures and semiotic tools, facilitated by technological progress, for knowledge construction. An increasing emphasis on the role of embodiment in learning highlights the significance of gestures and environmental interactions in cognitive development, reflecting semiotic theories that prioritize physicality in meaning-making as communication and learning models evolve alongside digital technologies (Jewitt, 2013; Skantz-Åberg et al., 2022). The concept of semiotic mediation, wherein tools and signs aid learning, undergoes reevaluation with the proliferation of digital media, positioning technology as a pivotal, active element in the educational process and as a novel cultural artifact with extensive semiotic capacity (Gourlay, 2015). This emerging research direction seeks to explore the interplay between technology and semiotics in educational contexts, aiming to transform gestures, culture, and media into innovative pedagogical

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frameworks (Kimmel et al., 2018), with a focus on developing educational technologies grounded in semiotic principles to enrich learning in a world increasingly blending the physical with the digital. This approach is set to provide valuable insights for enhancing the role of technology in education, recognizing the complex dynamics between semiotics, technology, and learning.

Cluster 3 (Blue): The 9 keywords in this cluster revolve around the central theme of "**Multimodal Mathematics Education Evolution**". Emerging trends in mathematics education are gravitating towards integrating systemic functional linguistics, multimodal resources, and the onto-semiotic approach, heralding a shift towards a comprehensive understanding of mathematical knowledge acquisition. The infusion of systemic functional linguistics underscores the pivotal role of language in grasping mathematical concepts, offering analytical tools to improve classroom communication and deepen learners' understanding of mathematics (Morgan et al., 2014). Simultaneously, the emphasis on multimodality moves beyond traditional text-based teaching, engaging learners through visual, auditory, and gestural modes, recognizing diverse learning styles and the various ways students process and articulate mathematical knowledge (Abrahamson et al., 2020). Furthermore, the onto-semiotic approach highlights the complexities of mathematics learning and teaching, urging educators to consider the myriad of signs, symbols, and meanings that influence cognitive processes in mathematics. The focus on "teacher education" indicates a pressing need for teacher training programs to incorporate these advanced methodologies, preparing educators to navigate a classroom environment rich in linguistic and semiotic diversity (Colwell & Enderson, 2016). This convergence of linguistic, multimodal, and semiotic methodologies in mathematics education points towards future research and pedagogical practices aimed at enriching how mathematical concepts are conveyed, comprehended, and engaged with, promising more effective and inclusive instruction.

Cluster 4 (Yellow): This cluster contains 9 keywords under the heading "**Constructive Frameworks in Science Education**". The current trajectory in science education, as indicated by keywords such as classroom, construction, framework, instruction, representations, science, students, and teachers, highlights a shift towards active learning and knowledge construction. This shift anticipates a move towards student-centered learning environments, where scientific concepts are actively constructed through student engagement and exploration, rather than passively received. Representations play a key role by offering students diverse ways

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to visualize and understand complex scientific ideas, enhancing comprehension and retention (Eilam & Gilbert, 2014). The role of teachers is evolving from mere transmitters of information to facilitators who guide students through personalized and exploratory learning experiences (Zydziunaite, 2021). This trend towards constructivist methodologies emphasizes learning as a process of building on prior knowledge and experiences, underpinned by pedagogical frameworks that are both structured and adaptable (Barak, 2017). Such frameworks aim to support teachers in crafting interactive, inquiry-based learning scenarios that promote critical and creative thinking. The focus is on integrating active participation, diverse representations, and constructivist instructional strategies, highlighting the necessity of evolving teaching methods to address the complexities of scientific knowledge and meet varied student learning needs. Future directions in science education research and practice are likely to further develop these frameworks, enhancing science education's efficacy and inclusivity for all students.

Cluster 5 (Purple): This cluster, with the theme "**Multiliteracies in Multimodal Pedagogy**" contains 8 keywords. The convergence of keywords such as design, literacy, multiliteracies, multimodality, pedagogy, social semiotics, texts, and writing signals a forward-thinking movement in educational practices. This movement broadens the scope of literacy to include not only traditional reading and writing but also engagement with diverse textual forms and communicative practices, vital in today's media-saturated environment. Emphasizing a proactive, creative approach to learning, the integration of multiliteracies into pedagogy encourages students to become active participants in constructing knowledge (García-Almeida & Cabrera-Nuez, 2020). Multimodality underscores the significance of employing various communication modes—visual, auditory, linguistic, and spatial—in education, adapting teaching strategies to nurture a broad spectrum of literacy skills (Falloon, 2020). Social semiotics offers a framework for analyzing the societal role of texts and signs, underscoring the importance of context and social interaction in the meaning-making process (Hodge, 2016). This educational evolution aims to equip students with the literacy competencies necessary to critically navigate and produce multimodal texts, preparing them for a future where communication transcends traditional boundaries (Mills & Unsworth, 2017). This trend predicts an educational future where literacy education embraces an expanded range of competencies, urging educators to cultivate learning experiences that mirror the complexity of contemporary communication.

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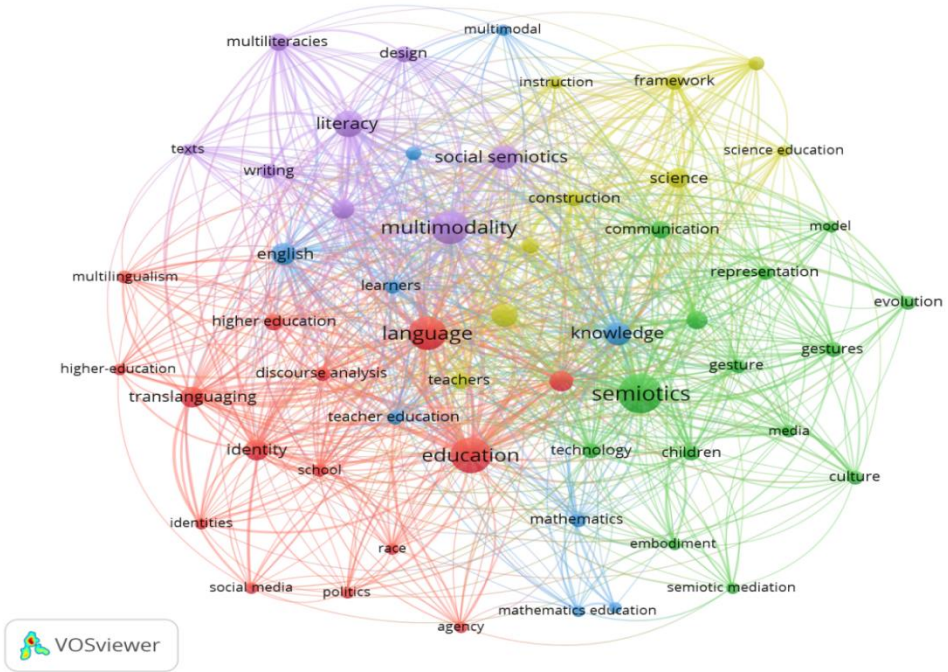
Table 4

The 15 Most Frequent Keywords in the Keyword Co-occurrence Analysis

Rank	Keyword	Occurrences	Total link strength
1	semiotics	230	281
2	education	188	366
3	language	168	330
4	multimodality	167	344
5	literacy	110	271
6	social semiotics	87	173
7	knowledge	85	168
8	students	79	200
9	english	76	170
10	identity	68	148
11	discourse	67	136
12	translanguaging	66	149
13	science	62	149
14	pedagogy	57	138
15	learning	55	89

Figure 3

Co-word Analysis of Semiotics in Education



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The co-word analysis of semiotics in education was summarized in Table 5, which included cluster labels, the number of keywords, and representative keywords.

Table 5
Co-word Analysis of Semiotics in Education

Cluster No. and colour	Cluster label	Number of keywords	Representative Keywords
1 (red)	Semiotics in Multilingual Education Evolution	15	"agency", "discourse", "discourse analysis", "education", "higher education", "higher-education", "identities", "identity", "language", "multilingualism", "politics", "race", "school", "social media", "translanguaging".
2 (green)	Semiotics and Learning in Digital Age	14	"children", "communication", "culture", "embodiment", "evolution", "gesture", "gestures", "learning", "media", "model", "representation", "semiotic mediation", "semiotics", "technology".
3 (blue)	Multimodal Mathematics Education Evolution	9	"English", "knowledge", "learners", "mathematics", "mathematics education", "multimodal", "onto-semiotic approach", "systemic functional linguistics", "teacher education".
4 (yellow)	Constructive Frameworks in Science Education	9	"classroom", "construction", "framework", "instruction", "representations", "science", "science education", "students", "teachers".
5 (Purple)	Multiliteracies in Multimodal Pedagogy	8	"design", "literacy", "multiliteracies", "multimodality", "pedagogy", "social semiotics", "texts", "writing".

Note. Author's interpretation derived from VOSviewer analysis

5. Implications

The bibliometric analysis on the semiotics landscape in education brings forth a comprehensive understanding of how semiotics, multimodality, and multiliteracies intersect to redefine the traditional notions of literacy and learning. This synthesis uncovers a pivotal shift towards acknowledging a broader spectrum of literacy that includes the capability to navigate, interpret, and create meaning across various semiotic resources beyond mere text. This expanded concept of literacy necessitates a reevaluation of educational strategies to include a curriculum that fosters diverse communicative competencies. The theoretical implications of this analysis suggest a movement away from conventional literacy teaching methods towards embracing a wide array of semiotic modes, including visual, digital, and textual forms, to cater to

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the evolving communicative landscape of the digital age. The analysis also highlights the critical role of semiotic mediation in learning, rooting its theoretical underpinnings in Vygotsky's cognitive development theory. This perspective emphasizes the significance of cultural tools and social interaction in the learning process, positioning diverse semiotic resources as central to cognitive development (Shvarts & Abrahamson, 2023). It calls for educational practices to leverage these tools effectively, advocating for a shift in viewing semiotic resources as integral to mediating learning processes. This signifies a theoretical evolution towards recognizing the complex interactions between learners and the semiotic environment, underscoring the need for pedagogical approaches that are reflective of the multimodal nature of society's communication. Furthermore, the synthesis points to the necessity of reimagining pedagogical practices and teacher education programs to align with the demands of a semiotically rich educational landscape. This entails developing pedagogies that are adaptive and inclusive, capable of engaging learners with a multitude of semiotic modes to foster a holistic educational experience. The implications extend to teacher education, emphasizing the importance of equipping educators with the requisite skills to navigate and utilize semiotic resources in the classroom effectively. Ultimately, this analysis calls for a paradigm shift in educational research and practice, advocating for an integrated approach that acknowledges the interplay of semiotics, multimodality, and multiliteracies in shaping future educational endeavors.

Practical implications emphasize reimagining pedagogies and teacher education to suit a semiotically enriched educational landscape, promoting adaptive and inclusive teaching strategies that engage students with multiple semiotic modes for a comprehensive learning experience. This entails curriculum redesign to incorporate multiliteracies and multimodal content, preparing students for the 21st-century's communicative demands. Furthermore, teacher training programs must evolve to equip educators with skills to effectively use semiotic resources in classrooms, enhancing learning through diverse communication modes (Darling-Hammond, 2020; Greenhow & Chapman, 2020). Additionally, creating learning environments that respect sociocultural student dynamics, integrating translanguaging strategies, and designing equitable multimodal assessments are crucial steps toward an inclusive educational setting (Savva, 2016). This analysis advocates for an educational paradigm shift, encouraging an integrated approach that recognizes semiotics, multimodality, and multiliteracies' roles in shaping future educational practices. By

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embracing the communicative environment's complexity, educators can offer enhanced education quality, preparing students for the digital age's opportunities and challenges.

6. Conclusion

Our study makes a vital contribution to understanding semiotics, multimodality, and multiliteracies within educational research through detailed bibliometric analysis, distinguishing our work from traditional explorations by examining key publications, leading scholars, and emerging research topics. This meticulous approach uncovers crucial research gaps and illuminates future scholarly directions, offering a comprehensive guide for educators, researchers, and policymakers navigating this multifaceted domain. However, our exclusive reliance on the WOS database may have narrowed our analysis scope, potentially overlooking valuable contributions from other prestigious publications. Expanding future research to include diverse databases could broaden our understanding and introduce a wider spectrum of academic insights. Additionally, integrating qualitative methods could reveal more profound insights into the themes identified, providing a richer narrative and nuanced understanding of semiotics in education. A significant research gap noted is the complex relationship between semiotics, technology, and pedagogy across various educational levels and cultural contexts, suggesting a valuable direction for future studies. Investigating this relationship could offer deeper insights into semiotic practices' impact on learning outcomes in different educational settings, thereby enriching the academic discourse in education and semiotics.

[DOI: 10.48311/LRR.15.5.283]

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Acknowledgments: This work was conducted under the supervision of Dr. Thawascha Dechsubha from Shinawatra University and Prof. Yongxiang Wang from Nanjing Normal University. They have also been listed as the second and third authors. We are also grateful to the insightful comments suggested by the editor and

[DOI: 10.48311/LRR.15.5.283]

the anonymous reviewers.

Conflicts of interest/Competing interests: The authors declare that they have no conflict of interest.

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[DOI: 10.48311/LRR.15.5.283]