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Scientometric Exploration of Rhizomatic Learning in Theory and Practice

Exploración cienciométrica del aprendizaje rizomático en teoría y práctica

Yenny Lisbeth Castro-Rojas, Universidad Metropolitana de Educación Ciencia y Tecnología UMECIT, Universidad Nacional Abierta y a Distancia UNAD (Panamá) (yennylcastro@gmail.com) (https://orcid.org/0000-0002-8014-3436)
Johan Hernán Pérez*, Universidad de Investigación y Desarrollo UDI (Colombia) Universidad Metropolitana de Educación Ciencia y Tecnología UMECIT (Panamá) (johan.perez@uptc.edu.co) (https://orcid.org/0000-0003-1501-5195)
Yamile Pedraza-Jiménez, Universidad Pedagógica y Tecnológica de Colombia UPTC (Colombia) (yamile.pedraza@uptc.edu.co) (https://orcid.org/0000-0001-9907-7101)

* Indicates the corresponding author

ABSTRACT
Rhizomatic Learning (RL) is an innovative and non-linear educational approach, based on the rhizome theory proposed by Gilman (1989). Unlike traditional teaching models, RL is decentralized and allows for multidirectional connections, promoting interconnectivity and adaptability in the construction of knowledge. Although its potential has been widely acknowledged, RL remains an emerging field that requires further scientific support from various perspectives. This article aims to conduct a scientometric analysis to map the scientific production related to RL and identify prevailing trends in the field. To achieve this, bibliometric data from Web of Science (WoS) and Scopus were used, structuring the study into two parts: a general mapping of the scientific output and the application of the Tree of Science (ToS) algorithm. Results show a steady growth in interest in RL, with a 21.65% increase in production since 2024, with the United States and the United Kingdom leading in the number of publications. Three main trends were identified: the integration of learning in the arts and cultural heritage, innovative pedagogical strategies in the classroom, and the exploration of cultural experiences in early childhood education. This study contributes to the conceptualization and visibility of RL as a driver of educational innovation.

RESUMEN
El aprendizaje rizomático (RL) es un enfoque educativo innovador y no lineal, basado en la teoría del rizoma de Gilman (1989). A diferencia de los modelos tradicionales, el RL es descentralizado y permite conexiones multidireccionales, lo que favorece la interconectividad y la adaptabilidad en la construcción del conocimiento. Aunque su potencial ha sido ampliamente reconocido, el RL aún representa un campo emergente que requiere mayor respaldo científico desde diversas perspectivas. Este artículo tiene como objetivo realizar un análisis cienciométrico para mapear la producción científica relacionada con el RL e identificar las tendencias predominantes en el área. Para ello, se utilizaron datos bibliométricos provenientes de Web of Science (WoS) y Scopus, organizando el estudio en dos partes: un mapeo general de la producción y la aplicación del algoritmo Tree of Science (ToS). Los resultados muestran un crecimiento constante del interés en RL, con una tasa de incremento del 21.65% desde 2024, destacando Estados Unidos y Reino Unido como los países con mayor número de publicaciones. Se identificaron tres tendencias principales: la integración del aprendizaje en las artes y el patrimonio cultural, estrategias pedagógicas innovadoras en el aula, y la exploración de experiencias culturales en la educación inicial. Este trabajo contribuye a la conceptualización y visibilidad del RL como motor de innovación educativa.

KEYWORDS | PALABRAS CLAVE
Educational Innovation, Pedagogical Practices, Rhizomatic Learning.
Innovación educativa, prácticas pedagógicas, aprendizaje rizomático.

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1. Introducction

Rhizomatic Learning (RL) presents an innovative and non-linear approach to the educational process. Rooted in the rhizome theory of Gilman (1989), RL differs from traditional models through its decentralized nature and multidirectional connections, akin to the structure of a rhizome (Acosta-Corporan, Martín-García, & Hernández-Martín, 2022; Gilman, 1989; Scanlon, MacPhail, & Calderón, 2022). While conventional teaching follows a hierarchical and predetermined sequence (Ahonen et al., 2018; López-Rey, 2024), RL enables learners to engage from multiple entry points, forging connections across diverse areas of knowledge. Interconnectivity and adaptability are central, fostering the co-construction of knowledge in an organic and continuous manner (Al-Rawahi & Al-Mekhlafi, 2015; Allen & Penuel, 2015).

RL is considered a novel educational approach because it promotes learner autonomy, interdisciplinarity, and creative problem-solving—competencies identified as essential for the 21st century by UNESCO (2023) and OECD (2023). Even within the stringent policies and curricular restrictions typical of higher education institutions (HEIs), RL principles can be integrated into elective modules, interdisciplinary research projects, and community-based learning initiatives without contravening institutional frameworks. Recent studies highlight RL's potential in fostering innovative practices in higher education (Lora-Guzmán, Castilla-Paternina, & Góez-Flórez, 2020; Malmberg et al., 2015; Martin et al., 2020) and in specific domains such as arts and cultural heritage (Baker, Bernard, & Dumez-Féroc, 2012) and early childhood education (Ampartzaki et al., 2024). Empirical evidence also points to RL's effectiveness in enhancing collaborative problem-solving (Ahonen et al., 2018), creativity (Álvarez, 2019), and learner engagement in digital environments (Valencia-Hernández et al., 2020).

The choice of RL as the focus of this study stems from its underrepresentation in scientometric research and the increasing adoption of decentralized and adaptive learning models in a digitally interconnected society (Azevedo, 2015; Baker et al., 2012). However, the absence of comprehensive scientometric mapping of RL across disciplines limits our ability to identify key actors, influential works, and conceptual trends. Addressing this gap is essential to advancing theoretical understanding and supporting practical applications (De la Barrera, Mónaco, & Valero-Moreno, 2023).

Accordingly, this study is guided by the following research questions: (1) What are the main trends, actors, and countries contributing to RL research? (2) How has RL evolved conceptually over time according to the Tree of Science (ToS) model? and (3) In which domains is RL most frequently applied, and what patterns can be identified?

To address these questions, we integrate data from Scopus and Web of Science, applying a dual scientometric approach that combines descriptive mapping of authors, countries, and journals with conceptual structuring using the ToS algorithm (Álvarez, 2019; Aprianto & Zaini, 2019). The contribution of this work lies in providing the first integrated scientometric mapping of RL, revealing its intellectual structure, identifying domains of application, and offering a reference framework for educators, researchers, and policymakers (Orozco Alvarado & Díaz Pérez, 2018).

This study aims to conceptualize Rhizomatic Learning, identify diverse practices associated with its implementation, and analyze their potential to promote disruptive educational innovation. Additionally, it seeks to highlight the growing importance of RL in innovative education and to emphasize the need for fostering international collaborations that can enrich the field.

2. Methodology

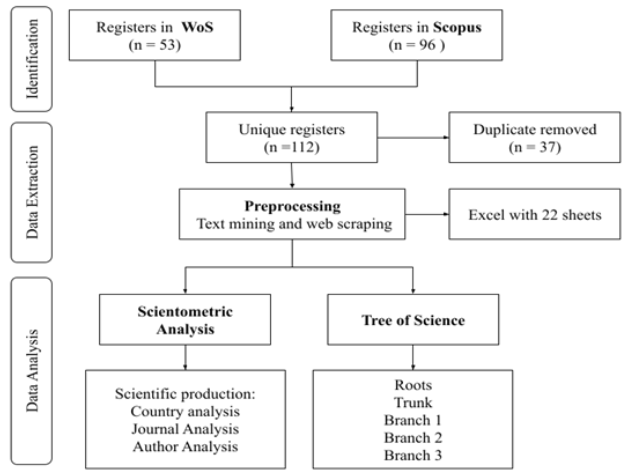
To map the literature on RL, a scientometric analysis was conducted. Scientometrics is a field of study that applies quantitative methods, statistics, and analysis to measure productivity and development across various scientific disciplines (Marín Suelves, Cuevas Monzonís, & Gabarda Méndez, 2021; Yu & Xiang, 2024). Using bibliometric data, which includes information on authors, texts, countries, citations, and other relevant metrics, it is possible to identify patterns, knowledge networks, impact, and publication trends within a given field of study (Berrocal-Caparrós & Ruiz-Velazco, 2023; Mármol-Castillo et al., 2022).

This approach has been widely used in state-of-the-art reviews across various fields to help researchers understand the evolution and recent advancements in their areas of study (Robledo & Zuluaga, 2022). Typically, scientometric analyses are conducted in four steps: identification of references, data extraction, computation of results, and analysis of the findings (Hove, Olugbara, & Singh, 2024). For this investigation, the process began with identifying the relevant literature through a search based on the parameters outlined in Table 1.

Table 1: Search Parameters Used in Scopus and Web of Science Databases.		
Criterios	Web of Science	Scopus
Range	2007 - 2024	
Date	April 17, 2024	
Document types	Articles, Reviews, Books, Chapters, Conferences	
Words	"rhizomatic learning" OR "rhizomatic education" OR "rhizomatic approach" OR "rhizomatic pedagogy"	
Results	53	96
Total (Wos+Scopus)	112	

A total of 53 documents were found in the WoS and 96 in Scopus. From there, a sequence of actions was followed as summarized in Figure 1. First, it is necessary to identify unique records since there are references that appear in both databases. This process is complex due to the different formats used by WoS and Scopus. This complexity is one reason why scientometric studies often rely on a single database, in addition to the fact that existing software typically supports information from only one source (Brouwer et al., 2012).

Figure 1: Overview of the General Methodology.



To identify duplicate records, the R packages bibliometrix (Aria & Cuccurullo, 2017) and tosr (Robledo et al., 2022), were used. Bibliometrix was employed to merge the primary records, while tosr was used to unify the cited references in each work. As a result, 112 unique documents were identified between WoS and Scopus, indicating that a significant portion of documents were present in one database but not the other. This situation underscores the importance of using both databases for this type of analysis (Cano-Vargas & Osorio-Toro, 2024). One of the distinctive values of this article is the integration of data from both WoS and Scopus into a single scientometric analysis.

To obtain the necessary inputs for the scientometric analysis, it was essential to homogenize the information contained in the references. This was achieved by applying text mining and web scraping techniques. Specifically, text mining was applied to the Scopus references to separate the authors, journals, and publication years, as Scopus uses different formats depending on the type of document (articles, book chapters, or conference proceedings). For the Web of Science (WoS) information, web scraping techniques were employed using CrossRef via the DOI. This process resulted in an Excel file with 22 sheets to facilitate more efficient subsequent data processing, as explained in the work of Robledo and Zuluaga (2022).

For presentation purposes, the data analysis was divided into two sections. The first section is a general scientometric mapping of scientific production, which examines the evolution of scientific output over time, identifying the most productive countries, journals, and authors. This perspective allows new researchers to identify periods of growth and peaks in the impact of published works over the past twenty years. This

is complemented by an analysis of collaboration networks between countries and the identification of author collaboration networks over time (Dolfing et al., 2021).

The second section presents the results of applying the ToS algorithm, whose foundations have been developed, tested, and applied in various previous publications (Eggers et al., 2022; Hurtado-Marín et al., 2021; Robledo, Osorio, & Lopez, 2014; Valencia-Hernández et al., 2020). Its use is highlighted in different fields of knowledge such as innovative entrepreneurship (Cano-Vargas & Osorio-Toro, 2024), port operations (Gerrero-Molina, Vásquez-Suárez, & Valdés-Mosquera, 2024), operations strategy (Vivares, Avella, & Sarache, 2022), environmental studies (Aguirre & Paredes Cuervo, 2023; Ariza-Colpas et al., 2024), tourism (Ariza-Colpas et al., 2023), health (Urina-Triana et al., 2024), organic coffee production (Gómez-Ortiz & Vivares-Vergara, 2024), and marketing (Duque, Cárdenas, & Robledo, 2024). Finally, it is noted that the results and figures were generated using R, Python, and Gephi software packages. Additionally, several figures were consolidated and enhanced using Inkscape software to compact the results for analysis.

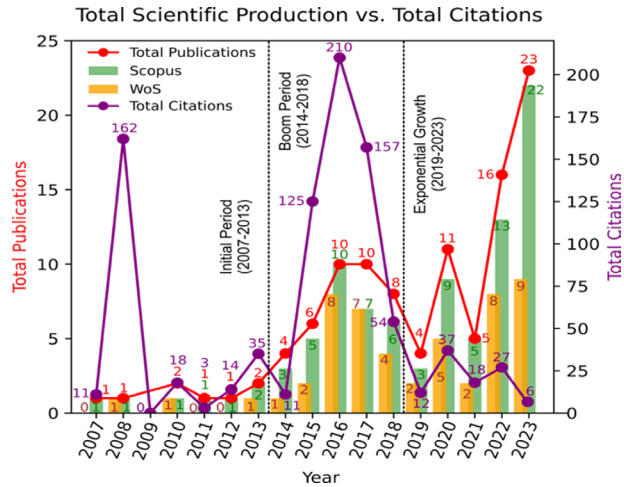
3. Results

3.1. Scientometric Analysis - Scientific Production

Scientific research on RL has displayed a consistent increase (Figure 2) with a growth rate of 21.65% from 2007 to 2024. This indicates the growing significance of RL in understanding innovative educational practices. In terms of analysis, it is noteworthy that the Scopus platform contains the largest number of articles especially in recent years, followed by WoS. A progressive increase in the number of publications has been observed since 2014, reaching its peak in 2024. This trend indicates a growing interest and relevance in research on RL. The evolution of scientific production can be segmented into three periods: the Initial Period, the Boom Period, and the Exponential Growth Period. The Initial Period (2007-2013) exhibited a growth rate of 12.25%. The Boom Period (2014-2018) had a noteworthy impact, with a peak growth exceeding 50% from 2014 to 2016, resulting in an overall growth rate of 18.92% for the period. Following a downturn in 2017-2018, the Exponential Growth Period (2019-2024) revealed a rapid upward trend, with a publication growth rate of 54.85%, underscoring the escalating scholarly interest in RL.

The evolution of scientific production exhibited two peaks in citations in 2008 and 2016, indicating that the works during these periods had a significant impact on the scientific community. A notable contribution to this result was the work of Sermijn, Devlieger and Loots (2008), which employs the rhizome metaphor of French philosophers Gilman (1989), as an experimental methodological concept to study the narrative construction of the self. By considering the self as a rhizomatic story, the authors create a narrative structure that not only provides valuable insights into how individuals construct their identity narratively but also encourages experimentation with alternative and non-traditional forms of presentation (Borge et al., 2020; Castles, Rastle, & Nation, 2018).

Figure 2: Trends in Scientific Production and Total Citations Over Time.



In 2016, the works of Masny (2016) and Bozkurt et al. (2016), gained considerable recognition within the scientific community. These studies reveal RL as a powerful methodology for addressing complexity and heterogeneity in education and research. Rhizoanalysis offers a way to interpret data in a non-linear and multifaceted manner (Masny, 2016). While connectivist MOOCs demonstrate how interactions and communities form and evolve chaotically yet effectively in open learning environments (Bozkurt et al., 2016). Both approaches emphasize the importance of flexibility, multiplicity, and connectivity in knowledge construction and the formation of learning communities, providing a deeper and more holistic understanding of the educational process in the digital age, including trends in scientific production and total citations over time (Figure 2).

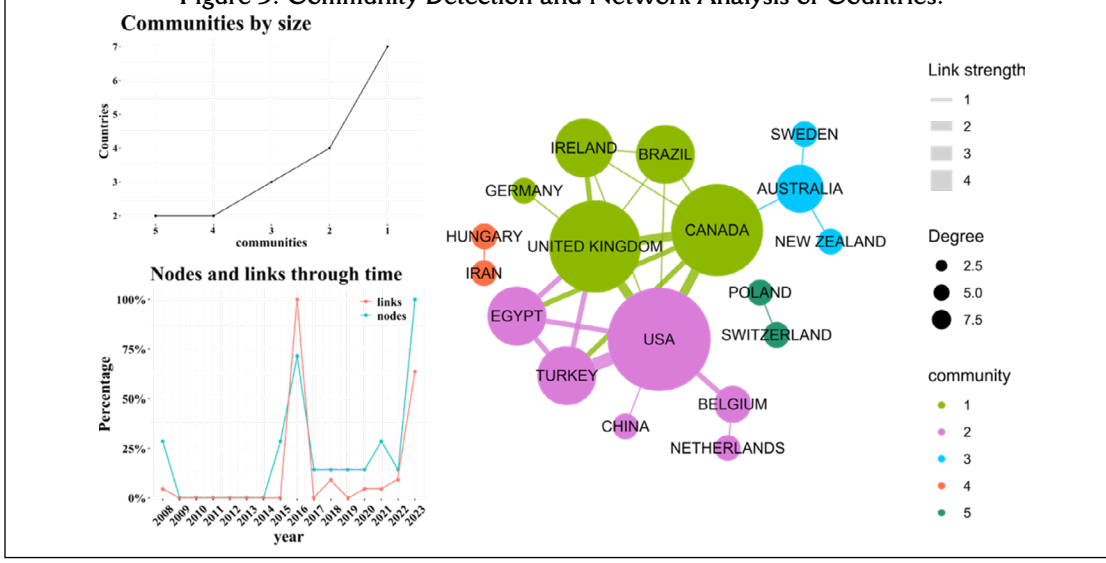
3.2. Country Analysis

The data in Table 2 illustrates the countries with the highest number of publications on RL. The leading country is the United States, with 14 publications, followed by the United Kingdom with 13, and South Africa with 10. These figures indicate that a significant portion of the publications are from the United States and the United Kingdom. Additionally, other countries such as Australia, Spain, Belgium, Italy, New Zealand, Sweden, and Canada also contribute a substantial number of publications. It is worth noting that European countries, particularly the United Kingdom, Spain, Belgium, Italy, and Sweden, collectively represent a substantial proportion of the total publications. Interestingly, Belgium stands out with the highest citation impact, boasting 105 citations, signifying its significant influence compared to other countries. These findings indicate that production volume is important, but the citation impact also plays a crucial role in determining the influence and reach of research in RL.

Table 2: Scientific Production and Citation Analysis by Country.

Country	Production		Citation		Q1	Q2	Q3	Q4
USA	14	13.73	54	10.07	4	3	0	1
United Kingdom	13	12.75	60	11.19	5	2	1	1
South Africa	10	9.8	35	6.53	2	2	3	1
Australia	9	8.82	56	10.45	3	1	0	0
Spain	8	7.84	43	8.02	1	3	0	1
Belgium	4	3.92	105	19.59	2	1	0	0
Italy	4	3.92	60	11.19	1	1	0	0
New Zealand	4	3.92	28	5.22	1	1	0	0
Sweden	4	3.92	19	3.54	1	0	0	1
Canada	3	2.94	32	5.97	1	1	1	0

Figure 3: Community Detection and Network Analysis of Countries.



Upon reviewing Figure 3, it is evident that in 2016 there was increased collaboration between countries, as indicated by a higher number of links compared to nodes in the network. However, in 2018, there was a significant decline in the number of links, which persisted until 2022. The network saw a recovery of links between nodes in 2024, reflecting renewed dynamism in collaborative relationships between countries. Additionally, two prominent communities were identified within the network: Community 1, where the United Kingdom and Canada emerged as key players, and Community 2, where the USA was highlighted as a central figure.

Some works integrate authors from various countries. For instance, the study by Bozkurt et al. (2016), brings together researchers from the United Kingdom, the United States, and Canada to explore the dynamics of MOOCs in terms of interactions, community formation, and student behavior through the analysis of hashtag interactions and other platforms. They investigate the formation of online communities that exemplify RL. Their mixed-method research reveals how connectivist communities evolve, mirroring the nature of RL and facilitating non-linear learning through virtual means (Buendía-Arias, Zambrano-Castillo, & Insuasty, 2018; Cisternas, 2011).

Similarly, the work by Floss et al. (2023), focuses on the need to educate primary care educators to address planetary health needs through the creation of a MOOC. This MOOC aligns with existing training programs and incorporates RL principles, emphasizing the necessity of free and accredited access to continuing education. This article was collaboratively authored by researchers from Brazil, Canada, Ireland, the United Kingdom, and the USA.

3.3. Journal Analysis

Table 3 presents the top 10 journals on RL. An important number of these journals are placed in the Q1 quartile, indicating their high-quality and influential research output. Notably, the Australasian Journal of Educational Technology and Qualitative Inquiry are particularly prominent, both being positioned in the Q1 quartile, emphasizing their significant role in disseminating research on RL. Qualitative Inquiry stands out with an impact factor of 1.13 and a high H Index of 102, highlighting its substantial influence and scholarly recognition. While the ACM International Conference Proceeding Series and the Turkish Online Journal of Distance Education have lower impact factors, they consistently contribute to the breadth of research dissemination, without detracting from the fact that ACM International Conference Proceeding Series has the highest H Index. Together, these journals play a crucial role in advancing the academic discourse on RL by reflecting diverse methodologies and perspectives.

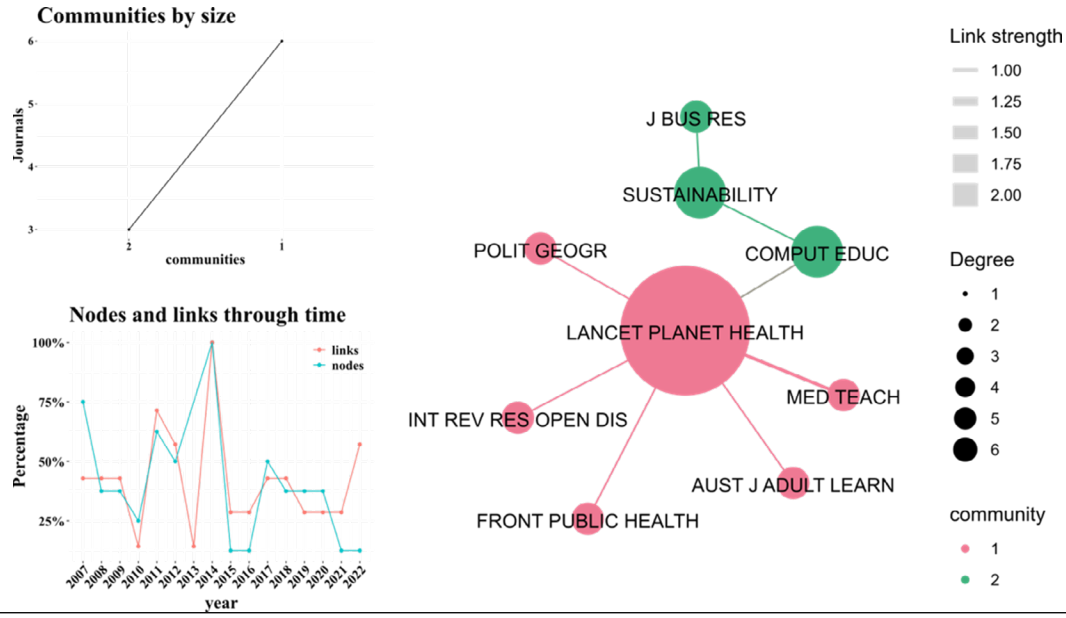
Table 3: Journal Analysis: Publication Metrics and Impact Factors.

Journal	WoS	Scopus	Impact Factor	H Index	Quartile
Rhizome Metaphor: Legacy of Deleuze and Guattari in Education and Learning	0	8	--	--	--
ACM International Conference Proceeding Seriaaes	0	2	0.25	151	--
Australasian Journal of Educational Technology	2	2	1	68	Q1
Childhood and Philosophy	1	1	0.22	5	Q2
English Studies	1	0	0.2	22	Q1
International Explorations in Outdoor and Environmental Education	0	2	--	--	--
Proceedings of the International Conference on E-Learning, ICEL	0	2	0	13	--
Qualitative Inquiry	2	2	1.13	102	Q1
Revista Electrónica de Leeme	1	0	0.45	7	Q1
Turkish Online Journal of Distance Education	2	2	0.52	32	Q2

The book "Rhizome Metaphor: Legacy of Gilman (1989), in Education and Learning" is noteworthy for its exclusive focus on the subject, despite not being ranked in the quartiles, as it hosts the largest number of publications on this topic. One of the chapters in the book identifies themes of convergent and divergent coherence (asignifying ruptures), providing a deeper analysis of participation patterns in RL (Chaka & Nkhobo, 2023). Recently, the 'Australasian Journal of Educational Technology' presented a study that challenges the assumption that visual literacy skills are acquired automatically and argues for the necessity of directed learning. This study proposes a rhizomatic model called m-learning (Guinibert, 2020). These works underscore the significance of RL models in contemporary educational research and practice.

Citation analysis serves as a powerful tool for identifying thematic areas within academic journals. Figure 4 delineates two thematic areas in journals on RL. The first component is prominently led by Lancet Plant Health, which features a proposal for a massive open online course (MOOC) on health, underpinned by RL principles (Aprianto & Zaini, 2019; Barenthien et al., 2020). The temporal depiction of nodes and links in the figure reveals a linear correlation between the percentage of nodes and links, suggesting that thematic consolidation through citation analysis has not yet been achieved among the articles.

Figure 4: Analysis of Journal Citation Networks and Thematic Communities in RL.



The analysis of bibliometric data highlights the productivity of authors as presented in Table 4. These authors have made significant contributions to the field, evidenced by their high publication output and elevated h-indices, reflecting their influence and leadership. Their cooperation positions them as central nodes in the network, facilitating the dissemination of knowledge and fostering new collaborations. An example of such collaboration is the work by Bell, Mackness and Funes (2016) and Mackness, Bell and Funes (2016), which explores how participants associate and develop a community in a Massive Open Online Course (MOOC) on RL (Rhizo14). This study identified tensions between the concept of "The Community is the Curriculum" Gilman (1989), principles of the rhizome.

Table 4: Author Contributions: Total Publications and Impact.

No.	Researcher	Total Articles	Scopus h-Index	Affiliation
1	Bell F	3	11	University of Salford, Salford, United Kingdom
2	Cochrane T	3	18	University of Canberra, Canberra, Australia
3	Mackness J	3	8	Independent Education Consultant and Researcher, United Kingdom
4	Bagui L	2	2	University of Cape Town, Cape Town, South Africa
5	Biffi A	2	2	Università degli Studi dell'Insubria, Varese, Italy
6	Bissola R	2	3	The University of New Mexico, Albuquerque, United States
7	Bozkurt A	2	22	ICAR - Directorate of Coldwater Fisheries Research, Bhimtal, Bhimtal, India
8	Chaka C	2	10	ICAR - National Institute of Abiotic Stress Management, Baramati, Baramati, India
9	Funes M	2	13	ICAR - Central Coastal Agricultural Research Institute, Goa, Old Goa, India
10	Imperatori B	2	25	Aalto University, Espoo, Finland

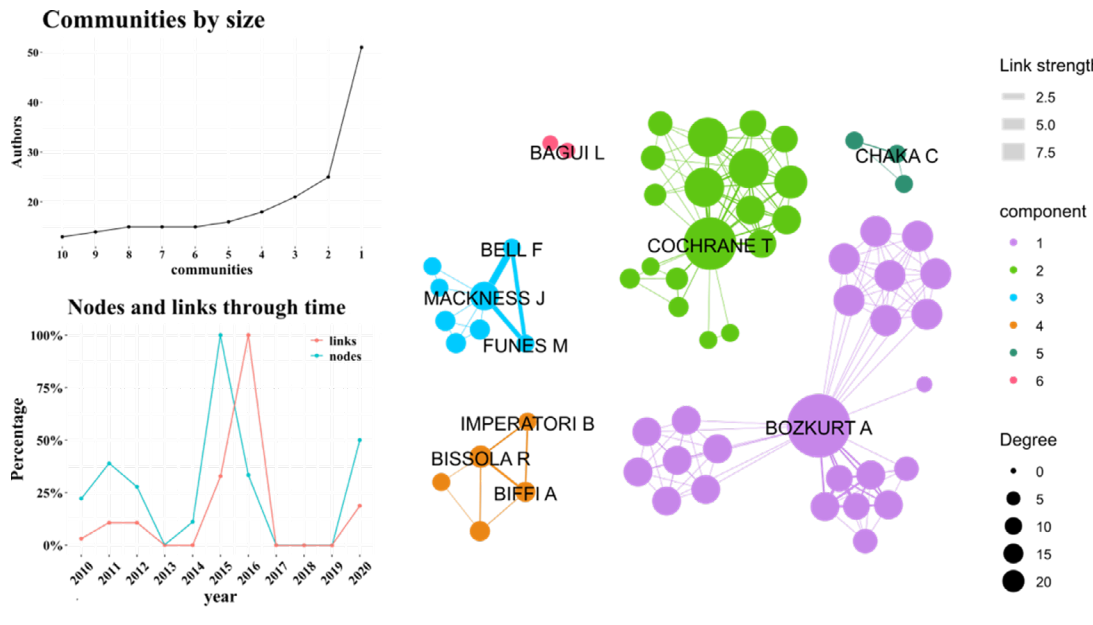
Meanwhile, Bissola, Imperatori and Biffi (2017) and Biffi, Bissola and Imperatori (2017), notable for their

independent contributions, collaborated to present a theoretical framework inspired by Gilman (1989), for entrepreneurship education. Their work focuses on RL to promote innovation and collaboration beyond traditional boundaries. They use the rhizome metaphor to describe a non-linear, collective, and adaptable learning process that fosters entrepreneurial capabilities such as risk-taking, positive thinking, and creative problem-solving (Bissola et al., 2017).

The review of communities and network analysis of countries reveals clusters of collaboration, suggesting close relationships between certain countries and authors (Fernandez & Johnson, 2015; Girón-Márquez, 2022). These international collaborations are prominent, with a notable exchange of knowledge between institutions in Europe, North America, and Asia (Bozkurt et al., 2016).

Figure 5 depicts the scientific collaboration network of the authors listed in Table 4. This network was constructed based on the personal networks (ego networks) of each author. Overall, the collaboration network is divided into six components, indicating that the community surrounding RL is fragmented, with authors lacking the connections needed to consolidate an academic community. This fragmentation is confirmed by the nodes and links graph over time, which shows that between 2017 and 2019, the authors did not generate new links or nodes (authors). It is noteworthy that Professors Bozkurt and Keefer (2018), Chaka and Nkhobo (2023) and Cochrane and Sinfield (2022), have worked separately. Meanwhile, the group of professors Mackness and Bell (2015), and another group composed of Biffi et al. (2017) and Bissola et al. (2017), have focused more on articulating processes of innovation and RL.

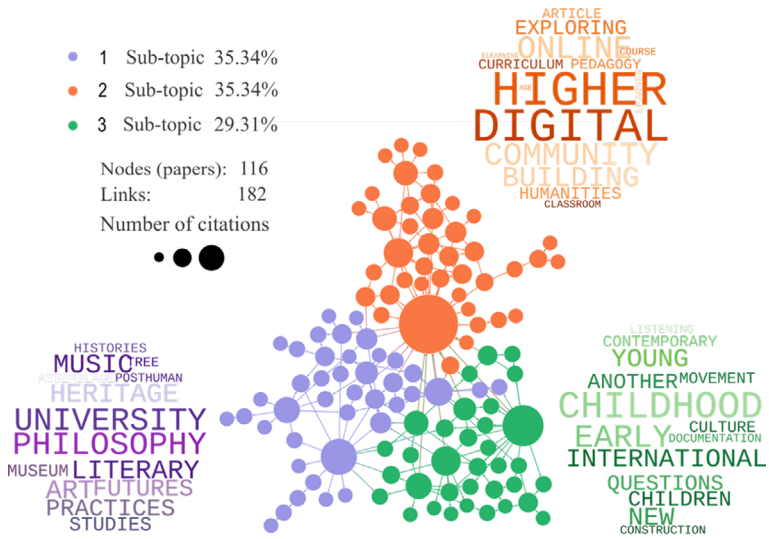
Figure 5: Ego Network Collaboration of the Most Productive Authors in RL Research.



3.4. Tree of Science Approach

Based on network theory, the ToS algorithm expands the identified references from the search and constructs a knowledge network through citations, dividing it into three parts: roots, trunk, and branches (de Guzmán & Tamayo Ly, 2017; Isohätälä, Järvenoja, & Järvelä, 2017). The roots encompass foundational works that were the precursors of the field of study. The trunk includes works that provided structural support due to their significant contributions to the field. Meanwhile, the branches represent thematic trends, and in this case, three distinct trends were identified (Figure 6). The following sections describe the results for the roots, trunk, and branches.

Figure 6: Tree of Science Branches.



3.5. Theoretical Roots of Rhizomatic Learning

RL, a concept rooted in the metaphor of rhizomes introduced by Gilman (1989), studies emphasizes a non-linear, interconnected approach to learning that stands in contrast to traditional hierarchical educational models. This idea has gained increasing attention in recent years, underscoring its potential to cultivate a more dynamic and adaptable learning environment. In the work Mackness and Bell (2015), the authors argue that RL empowers learners to forge their own paths and connections, leading to a deeper and more personalized comprehension of the material. Additionally, Cormier (2008), suggests that this approach can bolster student engagement and motivation by facilitating greater autonomy and creativity in the learning process. Moreover, Brailas (2020), demonstrates that RL can support lifelong learning by promoting ongoing exploration and adaptation to new information and contexts. This adaptability is particularly pertinent in today's rapidly evolving world, where the capacity to learn and relearn is increasingly valuable (Juárez-Popoca & Torres-Gastelú, 2022; Ketelaar et al., 2012).

Incorporating RL into educational practices also has significant implications for the role of educators and the structure of educational institutions. Referring to (Community tracking in a cMOOc and nomadic learner behavior), there is a highlighted need for educators to shift from being authoritative sources of knowledge to facilitators who guide and support learners in their individual journeys (Castro-Sandoval & Silva-Monsalve, 2023; Cifuentes-Garzón, 2021). This necessitates a change in teaching strategies and assessment methods to accommodate the fluid and emergent nature of RL. Additionally, Cormier (2008), discusses how technology can be utilized to create interconnected learning environments that reflect the rhizomatic model, allowing students to access and contribute to a vast network of knowledge. Furthermore, in the publication Mackness and Bell (2015), the challenges and opportunities of implementing RL in formal education settings are explored, including the requirement for institutional support and professional development for educators. By embracing the principles of RL, educational institutions can cultivate a culture of innovation and adaptability.

3.6. Core Contributions in Rhizomatic Learning Research

The exploration of RL represents an intriguing area of study. Here, we outline three significant articles that have been identified by the ToS algorithm as central or "trunk" articles. These articles serve as crucial nodes, connecting different strands of research and acting as essential links between related studies.

The first article, authored by Harris (2016), delves into the concept of RL, drawing from Gilman (1989), theory and employing the rhizome as a metaphor to depict non-linear, interconnected, and emergent learning pathways. This perspective contrasts traditional hierarchical educational models by advocating

for a more flexible and dynamic approach that views learning as an ongoing process of adaptation. Harris underscores the significance of this model within Community Massive Open Online Courses (cMOOCs), where learning communities naturally evolve through participant interactions (Koivuniemi, Järvenoja, & Järvelä, 2018; León-León & Zúñiga-Meléndez, 2019). This framework places emphasis on connectivity and community, challenging established ideas of objectivity and subjectivity in education. By scrutinizing "group think" and highlighting diverse perspectives, (Harris, 2016), calls for a more inclusive and participatory learning environment, despite the potential difficulties in upholding academic standards and offering structured guidance within cMOOCs (Dolfing et al., 2021; Harris, 2016).

The second article by Sermijn et al. (2008), delves into the concept of RL, particularly in the context of qualitative research methodologies. By drawing on the insights of Gilman (1989), the authors argue that rhizomatic stories, characterized by multiplicity, connectivity, and non-linearity, offer a more comprehensive representation of participants' experiences. This approach allows for the emergence of diverse narratives that capture the complexity and fluidity of human life, challenging conventional narrative structures. Through the use of narrative techniques and case studies, their qualitative research illustrates how learners can navigate and craft their own learning pathways, leading to a more personalized and engaging learning experience. The rhizomatic model underscores the importance of flexibility and adaptability in educational approaches, promoting collaboration, critical thinking, and creativity (Donado-Tolosa & Zerpa, 2009; Sermijn et al., 2008).

In the third and final article, Masny (2016), presents a compelling challenge to traditional qualitative research methodologies by blending Multiple Literacies Theory with rhizoanalysis. These innovative approaches seek to upend conventional notions such as observations and interviews, offering a non-hierarchical and non-linear perspective that expands the concept of literacy beyond the traditional school-based model. Influenced by Gilman (1989), rhizoanalysis eschews binary logic and the centralized subject, instead focusing on the fluidity and interconnectedness of knowledge. Masny (2016), underscores the interconnected nature of elements within an assemblage and the societal aspect of language, promoting a nomadic approach and experimental mindset in research. Through analytical vignettes, concepts such as "becoming drawing-writing" and "becoming recess-learning" illustrate novel ways of conceptualizing and conducting research, effectively revolutionizing traditional methodologies and cultivating innovative approaches in qualitative educational research (de Duran, Marcano, & Moronta, 2019; Prendes Espinosa, 2018).

4. Discussion

4.1. Integrating RL in Arts, Cultural Heritage, and Educational Practices

Through the reflections of various authors on the concept and contributions of RL and the necessity of fostering practical spaces and projects that emerge from collective construction, art becomes one of these forms that seek alternatives to adapt artistic education to knowledge networks. In the chapter by Höglund and Jusslin (2023), the authors focus on an innovative methodology for integrating the arts into literary and literacy education. They address unpredictability as a central element in teaching, proposing a rhizomatic approach that allows multiple and non-linear connections between different disciplines and areas of knowledge. This is based on strategies that provide teachers with tools to foster a dynamic and open learning environment. This approach contributes to the theory and practice of transcurricular didactics, offering new perspectives for secondary education that can be applied internationally (Fernandez & Johnson, 2015).

Rivero, Jové-Monclús and Rubio-Navarro (2023), narrate how edu-communication plays an essential role in transferring intangible cultural heritage from museums to formal education. This process adopts a co-creative approach, bringing new models based on collaboration and participation, imparting knowledge and experiences that foster networks among diverse communities and the educational sector, promoting a deeper and more participatory understanding of cultural heritage. This approach not only enhances the educational process but also strengthens community ties and the preservation of cultural heritage (Forbes, 2011). It allows the implementation of co-creative strategies that enable students to access knowledge and experiences, creating new methods of communication and education about the heritage they preserve.

The works of Rivero et al. (2023) and McGuire (2023), share a significant relationship in the context of museology and education, specifically in how they address communication and participation in cultural heritage management. McGuire (2023), advocates for a rhizomatic research approach in Caribbean museology, which involves a flexible and non-linear methodology for studying and managing heritage,

emphasizing a participatory approach through rhizomatic research. This suggests involving an authentic and dynamic representation of heritage in the museological process. Similarly, it proposes understanding and managing the complexities and multiple layers of cultural heritage, including intangible traditions, breaking away from traditional methodologies and proposing a more adaptable and responsive way of heritage management (Girón-Márquez, 2022). This demonstrates a shared vision of the need for greater community participation through innovative methods for cultural heritage management and education, where contemporary museology evolves towards more inclusive and dynamic practices, recognizing the value of active community contributions in the recognition, preservation, and transmission of cultural heritage (Lora-Guzmán et al., 2020; Malmberg et al., 2015; Martin et al., 2020).

Furthermore, Magno and Becker (2024), argue that modes, models, and mechanisms of governance need to be re-territorialized, forming new assemblages of structures, actors, and contextual educational landscapes. This is proposed through a post-critical educational leadership, essential for shaping the future of education, especially in contexts of complex, rapidly evolving, and self-generative systems. It seeks to ensure that school leaders understand and respond to their own needs, emotions, and positions in an increasingly complex and changing environment. This is achieved through a deep commitment to introspection and self-analysis, seeking new governance arrangements that foster a just and sustainable educational future. Therefore, this innovative approach is crucial for creating an educational system that effectively responds to contemporary challenges, promoting equity and sustainability (Gómez-Alcívar, Henríquez-Carrera, & Jordán-Yépez, 2019). It is thus essential to flexibilize structures of power, stability, and neoliberalism to enable new forms of participatory leadership, especially at the school level, characterized by cooperation, solidarity, trust, and justice.

Authors Sabbaghi (2022) and Gallo-Cadavid, Uribe-Pareja and Castañeda-Clavijo (2022), emphasize the importance of innovation and pleasure in the educational process, albeit from different perspectives. Sabbaghi highlights how innovation can serve as a bridge to connect diverse communities, promoting economic and social development through creative and collaborative practices in art, design, and entrepreneurship. On the other hand, Gallo-Cadavid et al. (2022), investigate the role of hedonism in university physical education by enjoying learning experiences, proposing a rhizomatic methodology that intensifies the teaching and learning experience through pleasure, enjoyment, and play. Both studies share a focus on enhancing the educational experience and empowering participants' creativity and well-being (Malmberg, Järvelä, & Järvenoja, 2017; Martin et al., 2020).

In the article by Hillier (2021), the author explores the application of Gilman (1989), concepts of "planitude" and "rhizome" in the context of urban planning. Hillier contrasts the traditional approach of planning the city as a tree, which implies a hierarchical and centralized structure, with the idea of planning the city as a rhizome, which is more decentralized, interconnected, and adaptable. This can limit the capacity of cities to adapt and evolve in the face of contemporary challenges. The author argues that adopting a rhizomatic approach to urban planning can promote greater flexibility, inclusion, and community participation, integrating multiple actors and perspectives into the urban development process (de Guzmán & Tamayo Ly, 2017). This promotes a more resilient and sustainable city, capable of responding to the complexities and changing dynamics of contemporary cities.

The study "Performative Music Education for Music Students: A Case Study" examines how performative music education can enrich the training of music students by connecting performative music education with RL (Ramírez-Martínez & Rodríguez-Quiles, 2020). Both approaches share a vision of learning as a non-linear and adaptive process, where exploration and the interconnection of different experiences and knowledge are fundamental. Performative music education, like RL, promotes a flexible and creative learning environment in which students can follow multiple paths of knowledge and develop their skills organically.

Movahedian et al. (2020), explore the rhizomatic approach in knowledge and information organization systems, with a particular emphasis on web spaces. They argue that the rhizomatic approach is suitable for the digital environment due to its ability to handle complexity, interconnection, and the non-linear nature of knowledge on the web.

Overall, this branch of study allows us to understand that rhizomatic approaches applied in both education and knowledge organization demonstrate the importance of flexibility, adaptability, interconnection, and transformation of traditional systems (Juárez-Popoca & Torres-Gastelú, 2022). By integrating and promoting more holistic and effective information management, these approaches can adapt to the needs and challenges of the contemporary world.

4.2. Innovative Pedagogical Strategies for Implementing RL in the Classroom

This subarea of RL relates to various curricular and pedagogical proposals aimed at implementing a RL model in classrooms. For example, Höglund and Jusslin (2023), explain that integrating dance and poetry into teaching leads to unpredictable yet valuable outcomes, but they also emphasize the necessity of destabilizing planned instruction. Additionally, Sousa (2023), proposes an exercise of inverting questions to trigger thought processes, highlighting the importance of giving children an epistemic and political voice equal to that of adults. For instance, a slight modification of the question "What is the ink of the pen made of?" to "The ink of the pen is made of what?" led to new reflections on the nature of questions. In this sense, this branch seeks to propose various methodological approaches to integrate RL in the classroom.

Another strategy to create learning environments that facilitate RL is the generation of specific incentives such as awards or rewards. For instance, Harrop and Hoppitt (2023), proposed the Student Extracurricular Engagement (SEE) Award to enhance the sense of belonging and participation of international students in extracurricular activities. The SEE Award is a framework of awards obtained through simple activities such as attending book club sessions or participating in a café. This is a practical example of how a rhizomatic approach can improve students' sense of belonging and participation. Another proposal to enrich educational environments with a RL approach is to embrace the uncertainty of such processes and move away from the over-planning of classes. Zaduski et al. (2023), propose a patternless methodology combined with constant integration of changes, suggesting that educational processes are not predefined paths. Therefore, it is necessary to have incentives and create high-uncertainty environments to facilitate RL in students.

RL has been studied both within and outside universities. For example, de Vries et al. (2023), designed and implemented a creativity course based on the ideas of Gilman (1989). This course encouraged students to solve complex problems through innovative ideas by identifying each student's passions and qualities. Students conducted autobiographical mapping of their environment and past, developing networks with other students. The authors concluded that a rhizomatic approach in a creativity class positively influences students' perception of creativity. On the other hand, Steele (2022), proposes a different approach by taking humanities learning processes outside university settings. The author combines theoretical speculation approaches, fostering free imagination, discussion, and debate. The methodology was based on the formulation of guiding questions and the exploration of solutions. The results showed that these processes stimulate imagination through reading groups. In conclusion, there are various curricular approaches to RL that range from formal to informal environments, demonstrating the versatility and impact of this methodology.

4.3. Limitations of the study in RL: Exploring Creative and Cultural Experiences in Early Childhood Education and Beyond

In the study of RL, the potential value of creative and cultural experiences for preschool children emerged as a significant trend. Works such as Wright (2020), highlight that, from this perspective, the focus is on advocating for galleries as democratic, inclusive, and rhizomatic spaces. These are places where it is essential to evaluate the quality of activities, documented based on structures organized around various communicative aspects of pedagogical documentation. Similarly, Alnervik (2018), emphasizes the importance of discussing and developing tools that enable communication structures based on RL, especially in preschool activities.

In this context, creating interaction spaces where planned activities present the trajectory of RL processes in children offers the possibility of approaching the curriculum through the interaction of multiple spontaneously established relationships, thereby conceptualizing rhizomatic connections (Isohätälä et al., 2017; Kim, 2023). This underscores the importance of reformulating the role of children's epistemic voice as an essential part of practice in various thinking situations, as mentioned by Sousa (2023). This author highlights the role of children's questions as a critical part of the thinking process, fostering a metacognitive approach through the concretization of an anastrophe of thought, where children practice logic and semantics, theory and practice from a rhizomatic perspective.

By configuring interactions in how humans think, interact, and communicate with other organisms through the rhizomatic approach, (Goldstein, 2021), illustrates assertively the variety of human interactions with ayahuasca, a "philosophical plant" representation. This facilitates an approach to cultural heritage through phytocommunicable strategies, establishing the theoretical characteristics of the rhizome as outlined

by Facca and Kinsella (2023). They describe the "Deleuzoguattarian rhizome," from which the concept of rhizoethics originates, consisting of possibilities for decentralizing positionality in research contexts as discussed by Masny (2016). In this context, power relations constantly change, establishing an onto-epistemological relationship from the perspective of interactions considered ethically significant. This is fundamental in qualitative research where the rhizomatic approach is explored to construct an assemblage through rhizoanalysis of data, advocating for multiplicity, uncertainty, and broadening experiences with the world through problem posing and questioning as pathways to an uncertain future (Ketelaar et al., 2012).

5. Conclusions

This article presents an exhaustive analysis of the literature on rhizomatic learning, aiming to understand its implications and benefits in the educational field. Through a scientometric study, sustained growth in scientific production on this approach was identified, reflecting its increasing relevance as a model of educational innovation. This rise in research also highlights the academic community's interest in exploring alternative teaching methods that respond to the challenges of contemporary learning environments.

Rhizomatic learning is characterized by its non-linear and decentralized nature, allowing the learning process to begin from multiple entry points. This fosters greater personalization and adaptability, adjusting to students' individual needs and learning paces. In this model, knowledge is constructed through transdisciplinary connections, which not only enrich content understanding but also promote critical, creative, and holistic thinking key elements for meaningful and transformative education.

The findings suggest that rhizomatic learning has the potential to strengthen future educational practices by promoting more flexible, interconnected, and collaborative environments. In the digital age, these characteristics are essential to generating inclusive and sustainable learning experiences. The model's adaptability to diverse educational contexts offers a significant advantage over traditional, hierarchical approaches.

Additionally, an important trend was identified in the study of rhizomatic learning in early childhood education. At this level, approaches go beyond the simple transmission of knowledge to focus on the creation of creative and cultural experiences that foster children's integral development. These proposals support the construction of democratic, inclusive, and interaction-based educational spaces, where *rhizoethics* emerges as an ethical stance in educational research, advocating for the decentralization of knowledge and the recognition of multiple ways of knowing.

Altogether, these findings not only reinforce the importance of rhizomatic learning as an emerging field but also inspire new lines of research and educational transformation. Integrating this approach into formal education systems may contribute to a more equitable, critical, and responsive education, offering pathways toward more open, collaborative, and learner-centered practices.

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