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A Bibliometric Study of Spiral Curriculum Research: Intellectual Structure and Future Directions

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ABSTRACT

This study aims to map the intellectual structure, thematic evolution, and future research directions of spiral curriculum research through a bibliometric approach. Data were collected from a reputable database and analyzed using VOSviewer to examine co-occurrence networks, temporal trends, and research density. The findings reveal that spiral curriculum research is characterized by strong interdisciplinary connections, with dominant clusters emerging in medical education, general curriculum and learning sciences, and engineering education. The network analysis indicates that spiral curriculum functions as a central pedagogical framework closely associated with key concepts such as teaching, learning, and curriculum design. The overlay visualization shows a clear temporal shift from early applications in technical and engineering domains toward broader educational theory and, more recently, toward applied and competency-based contexts, particularly in medical education. Furthermore, the density analysis highlights that while core themes are well-established, emerging areas such as motivation, decision-making, and technology-enhanced learning remain underdeveloped. These findings suggest that spiral curriculum research is transitioning toward more integrative and outcome-oriented approaches. This study contributes to the literature by providing a comprehensive knowledge map of spiral curriculum research and identifying potential avenues for future investigation, particularly in digital learning integration and interdisciplinary applications.

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1. INTRODUCTION

The concept of the spiral curriculum has become an influential idea in educational theory and curriculum design since it was first introduced by the cognitive psychologist Jerome Bruner in the early 1960s [1]. The spiral curriculum proposes that learning should be structured so that fundamental ideas are revisited repeatedly throughout a course of study, each time at a higher level of complexity and abstraction [2], [3]. Through this iterative process, students gradually deepen their understanding while reinforcing previously acquired knowledge (Bruner, 1960). The central premise of this approach is that learners can grasp complex concepts more effectively when they encounter them multiple times in progressively sophisticated forms [4], [5]. Such a structure contrasts with

traditional linear curricula that typically present topics once and move forward without systematic reinforcement.

The spiral curriculum emerged from constructivist views of learning that emphasize active engagement, prior knowledge, and cognitive development [6], [7]. Within this perspective, knowledge is not simply transmitted from teacher to student but constructed through interactions with ideas and experiences. The spiral structure supports this process by enabling learners to connect new information with existing cognitive frameworks. When students revisit previously introduced topics, they not only reinforce earlier knowledge but also integrate new insights that expand their conceptual understanding. Consequently, the spiral curriculum promotes cumulative learning, where each stage of instruction builds upon previous stages, forming a coherent and interconnected knowledge system.

In educational practice, the spiral curriculum has been applied across various disciplines, including science, mathematics, medical education, and engineering programs. In these contexts, foundational concepts are introduced early in simplified forms and revisited later with increasing complexity and practical applications. For example, in science education, students may initially learn basic principles of biology, chemistry, and physics and subsequently revisit these ideas with deeper theoretical explanations and experimental activities. This approach allows learners to progressively refine their understanding while strengthening their ability to apply knowledge in real-world situations. As a result, the spiral curriculum has been widely recognized as a strategy for promoting long-term retention and deeper conceptual mastery.

Despite its widespread adoption, research on the spiral curriculum has evolved significantly over the decades. Early studies primarily focused on theoretical discussions and conceptual models of curriculum design. More recent research has explored empirical evidence related to learning outcomes, instructional strategies, and curriculum implementation in different educational contexts. Advances in digital education, interdisciplinary learning, and competency-based education have also influenced how the spiral curriculum is applied and studied. These developments have led to a growing body of literature that examines the effectiveness, adaptation, and integration of spiral learning approaches in modern educational systems.

However, as the number of publications on spiral curriculum continues to increase, it becomes increasingly difficult to identify the intellectual structure, key themes, and emerging research directions within this field. Traditional narrative reviews may provide insights into specific aspects of the literature but often lack the systematic and quantitative perspective necessary to capture the overall development of a research domain. In this context, bibliometric analysis offers a valuable methodological approach for mapping scientific knowledge, identifying influential publications and authors, and revealing patterns of collaboration and thematic evolution. By applying bibliometric techniques to spiral curriculum research, scholars can gain a comprehensive understanding of how the field has developed over time and where future research opportunities may lie.

Although the spiral curriculum has been widely discussed and implemented in various educational settings, the existing literature remains fragmented and dispersed across multiple disciplines and research traditions. Many studies focus on specific case implementations or theoretical interpretations, making it challenging to obtain a comprehensive overview of the field's intellectual landscape. Furthermore, there is limited systematic analysis of publication trends, influential authors, collaboration networks, and thematic developments related to spiral curriculum research. Without such an overview, it is difficult for scholars and educators to understand the evolution of the field, identify key research clusters, or recognize emerging directions that may guide future studies. Therefore, there is a need for a comprehensive

bibliometric investigation that maps the intellectual structure of spiral curriculum research and provides insights into its development and future trajectory.

The objective of this study is to conduct a bibliometric analysis of spiral curriculum research in order to identify its intellectual structure, major research themes, influential publications, and patterns of scholarly collaboration. By examining the evolution of the literature over time, this study aims to reveal the development trends and emerging topics that shape the field. Ultimately, the findings are expected to provide a systematic overview of spiral curriculum scholarship and offer recommendations for future research directions that can advance theoretical understanding and practical implementation in education.

2. METHOD

This study employed a bibliometric research design to systematically examine the development and intellectual structure of scholarly publications related to the spiral curriculum. Bibliometric analysis is a quantitative method used to evaluate patterns in academic literature, including publication trends, citation relationships, and collaboration networks among researchers. Through this approach, large volumes of scientific publications can be analyzed to identify influential works, dominant research themes, and the evolution of knowledge within a specific field. In the context of this study, bibliometric techniques were used to map the structure of spiral curriculum research and to provide a comprehensive overview of how the topic has developed over time within educational scholarship.

The data used in this study were collected from a major international scientific database, such as Scopus or Web of Science, which indexes peer-reviewed journals, conference proceedings, and other academic publications. The search process was conducted using relevant keywords including "spiral curriculum," "spiral learning," and related terms appearing in article titles, abstracts, and keywords. To ensure the relevance and quality of the dataset, several inclusion criteria were applied, such as selecting only publications written in English, focusing on education-related subject areas, and limiting the document types to journal articles and conference papers. The retrieved records were then exported in bibliographic formats containing information such as author names, publication years, source titles, citations, and keywords. The dataset was further screened to remove duplicates and irrelevant records before being analyzed.

3. RESULT AND DISCUSSION

3.1 Result

a. Keyword Co-Occurrence Analysis

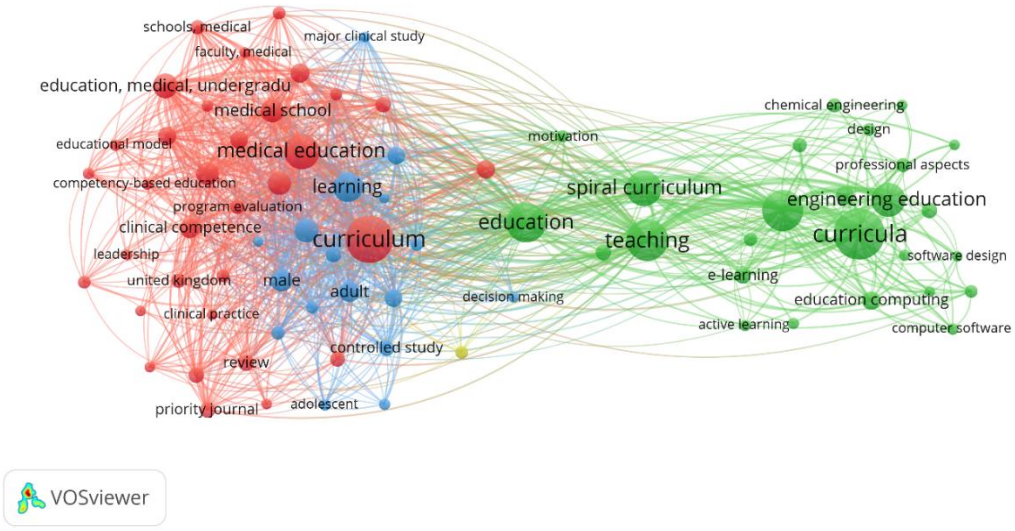

Figure 1. Network Visualization
Source: Data Analysis

Figure 1 reveals the intellectual structure of spiral curriculum research through three dominant thematic clusters: medical education (red), curriculum and learning sciences (blue), and engineering education (green). These clusters indicate that spiral curriculum research is not confined to a single discipline but is instead widely applied across different educational domains. The density and interconnection of nodes suggest a mature and interdisciplinary field, where core pedagogical concepts are adapted to suit domain-specific needs. The red cluster, centered on medical education, represents the most densely connected and possibly the most established research stream. Keywords such as "clinical competence," "medical school," "program evaluation," and "competency-based education" highlight a strong focus on professional training and skill development. This suggests that the spiral curriculum has been extensively implemented in medical education to support progressive skill acquisition, where students revisit clinical concepts with increasing complexity. The presence of terms like "clinical practice" and "leadership" further indicates that this cluster emphasizes real-world application and professional readiness.

The blue cluster focuses on foundational educational constructs such as curriculum, learning, and learner characteristics (e.g., "adult," "male"). This cluster acts as a conceptual bridge between domain-specific applications and general educational theory. It reflects research that examines how spiral curriculum principles are designed, implemented, and evaluated from a pedagogical standpoint. The inclusion of terms like "controlled study" and "review" suggests that this stream also incorporates empirical validation and systematic evaluation of curriculum effectiveness, reinforcing its role in evidence-based education research. Meanwhile, the green cluster highlights the application of spiral curriculum within engineering education and technology-related fields. Keywords such as "engineering education," "e-learning," "software design," and "education computing" indicate a growing emphasis on integrating spiral curriculum with digital learning environments and technical disciplines. This cluster reflects a shift toward modern educational contexts, where iterative learning is supported by technology-enhanced instruction and active learning strategies. The presence of "professional aspects" also suggests alignment with industry demands and workforce readiness in engineering domains.

The network demonstrates that spiral curriculum research is structured around a core pedagogical foundation that is adapted across professional and technical fields. The strong connections between clusters indicate knowledge transfer between disciplines, particularly from medical education to engineering and general education contexts. This suggests an evolution of the spiral curriculum from a theoretical concept into a versatile framework applied in diverse educational settings. Future research is likely to expand further into digital learning, interdisciplinary integration, and data-driven curriculum design, reflecting ongoing transformations in global education systems.

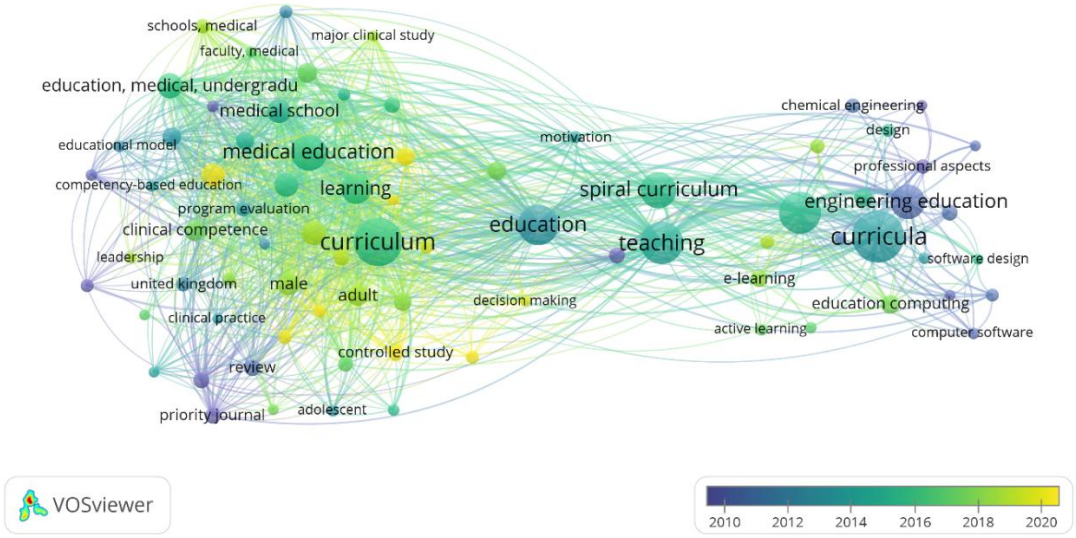

Figure 2. Overlay Visualization
Source: Data Analysis

Figure 2 illustrates the temporal evolution of spiral curriculum research, with colors ranging from blue (earlier studies) to yellow (more recent developments). The network shows that earlier research, predominantly before 2014, is concentrated around foundational areas such as engineering education, software design, and education computing. These earlier nodes suggest that initial applications of the spiral curriculum were closely tied to structured, technical disciplines where iterative learning processes align naturally with problem-solving and design-based education. As the field progressed into the mid-phase (approximately 2014–2017), the focus shifted toward more general educational constructs, including curriculum, learning, and education. These nodes appear in green tones, indicating a period where the spiral curriculum concept was being more broadly conceptualized and integrated into mainstream educational research. During this phase, studies began emphasizing pedagogical design, instructional strategies, and the theoretical underpinnings of iterative learning. The strong connectivity between these terms suggests that this period served as a consolidation stage, linking earlier domain-specific applications with more universal educational frameworks. In more recent years (2018–2020 and beyond), the visualization highlights a growing concentration of research in areas such as medical education, competency-based education, program evaluation, and learner-centered variables like adult and clinical competence, which are shown in yellow. This indicates that contemporary research is increasingly focused on applied, outcome-oriented contexts, particularly in professional education. The shift toward medical and competency-based domains suggests that spiral curriculum is now being leveraged to address real-world skill development, assessment, and continuous professional learning.

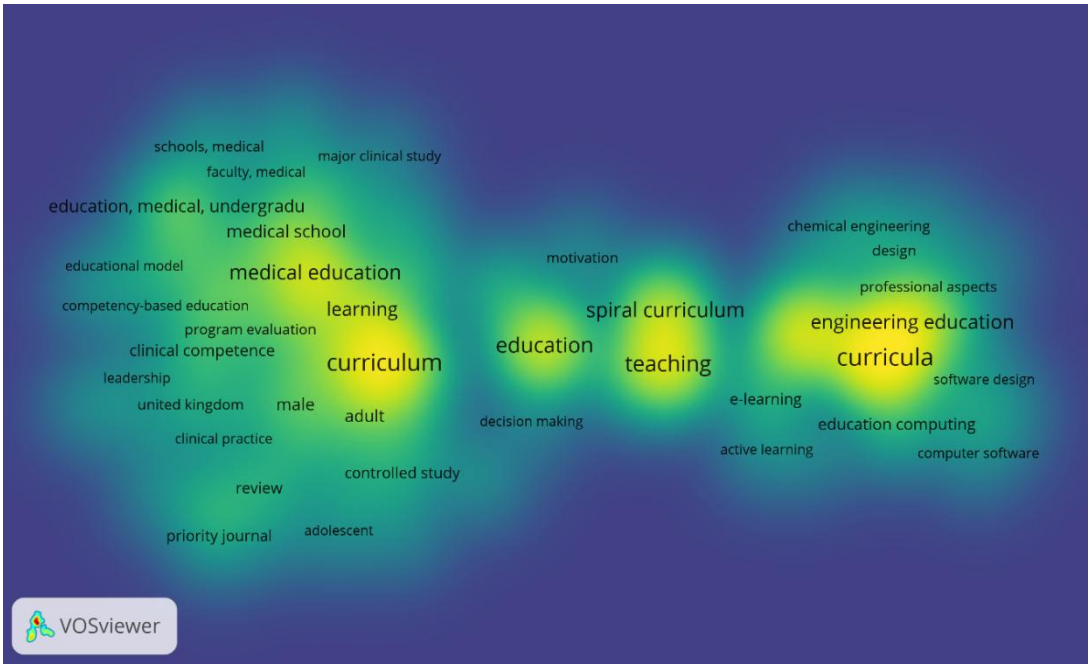

Figure 3. Density Visualization
Source: Data Analysis

Figure 3 highlights the most intensively studied areas within spiral curriculum research, where brighter yellow regions indicate higher frequency and stronger co-occurrence of keywords. The most prominent hotspot appears around curriculum, teaching, education, and spiral curriculum, suggesting that these concepts form the core intellectual foundation of the field. This central concentration reflects a strong emphasis on pedagogical design and instructional processes, indicating that the spiral curriculum is primarily examined as a framework for structuring learning experiences. Additionally, the presence of learning and medical education within high-density areas shows that much of the research is closely tied to applied educational contexts, particularly those requiring structured knowledge progression.

A second major density cluster is visible in the domain of engineering education and curricula, along with related terms such as education computing, software design, and e-learning. This indicates that technical and technology-oriented disciplines represent another significant concentration of research activity. Compared to the medical education cluster, this area appears slightly more specialized, focusing on the integration of spiral curriculum principles with digital learning environments and professional skill development. Meanwhile, peripheral terms such as motivation, decision making, and clinical competence appear in less dense regions, suggesting emerging or supporting themes that have not yet reached the same level of research intensity.

b. Citation Analysis

Table 1. Most Cited Article

Citations	Author and Year	Title
535	[8]	What is a spiral curriculum?

Citations	Author and Year	Title
523	[9]	Challenges and opportunities facing medical education.
401	[10]	Anatomy: A must for teaching the next generation
244	[11]	Learning progressions: Aligning curriculum, instruction, and assessment
242	[12]	Nature matrix: Reconnecting people and nature
218	[13]	The Sequence of Musical Development: A Study of Children's Composition
187	[14]	From scratch to "Real" programming
133	[15]	The new Dundee medical curriculum: A whole that is greater than the sum of the parts
119	[16]	A continuum of learning: From rote memorization to meaningful learning in organic chemistry
108	[17]	Planning and implementing an undergraduate medical curriculum: The lessons learned

Source: Scopus, 2026

3.2 Discussion

This study provides a comprehensive bibliometric overview of spiral curriculum research by mapping its intellectual structure, thematic evolution, and research density using VOSviewer. The findings reveal that spiral curriculum research is characterized by a strong interdisciplinary foundation, with three dominant domains emerging: medical education, general curriculum and learning sciences, and engineering education. Among these, medical education appears as the most prominent and mature field, suggesting that the spiral curriculum has been extensively adopted in professional training contexts where progressive knowledge acquisition and skill development are critical. This aligns with the pedagogical philosophy introduced by Jerome Bruner, emphasizing iterative learning and increasing complexity over time.

The network visualization demonstrates that the concept of spiral curriculum is not isolated but deeply interconnected with broader educational constructs such as teaching, learning, and curriculum design. The central positioning of these keywords indicates that the spiral curriculum functions as a core pedagogical framework rather than a niche concept. Furthermore, the strong linkage between clusters suggests a significant transfer of knowledge across disciplines. For instance, principles initially applied in medical education—such as competency-based progression and clinical skill reinforcement—have influenced curriculum design in engineering and technology-related education. This cross-disciplinary diffusion highlights the adaptability and scalability of the spiral curriculum in addressing diverse educational needs.

The temporal evolution captured in the overlay visualization reveals a clear shift in research focus over time. Early studies were predominantly concentrated in technical and engineering domains, reflecting the structured and iterative nature of these disciplines. Over time, research expanded into general educational theory, emphasizing curriculum development and instructional design. More recently, the field has shifted toward applied and outcome-oriented domains, particularly medical education and competency-based learning. This transition suggests that spiral curriculum research is moving from conceptual exploration toward practical implementation and impact assessment. The increasing attention to terms such as program evaluation and clinical competence indicates a growing

emphasis on measuring learning outcomes and ensuring the effectiveness of curriculum models.

The density visualization further reinforces these findings by highlighting the most intensively researched areas. Core concepts such as curriculum, teaching, and education form the central knowledge base, while applied domains like medical and engineering education represent high-density application areas. At the same time, several peripheral themes—such as motivation, decision-making, and active learning—remain less developed. These emerging topics indicate potential avenues for future research, particularly in integrating psychological and behavioral dimensions into spiral curriculum design. Additionally, the presence of e-learning and education computing suggests an ongoing shift toward digital and technology-enhanced learning environments, although these areas have not yet reached the same level of maturity as traditional domains.

These findings suggest that spiral curriculum research is entering a new phase characterized by integration, application, and innovation. Future research should focus on several key directions. First, there is a need to explore the integration of spiral curriculum with digital learning technologies, including artificial intelligence and adaptive learning systems. Second, more empirical studies are required to evaluate the long-term effectiveness of spiral curriculum models across different educational contexts. Third, interdisciplinary research should be strengthened to bridge gaps between educational theory, professional training, and technological innovation.

4. CONCLUSION

This bibliometric study demonstrates that spiral curriculum research has evolved into a well-established and interdisciplinary field, with strong roots in medical education and expanding applications in engineering and broader educational contexts. The findings reveal that the spiral curriculum serves as a central pedagogical framework closely linked to key concepts such as teaching, learning, and curriculum design, while its development over time reflects a shift from theoretical exploration to practical and outcome-oriented implementation. Despite the maturity of core themes, emerging areas such as digital learning integration, learner motivation, and data-driven curriculum design remain underexplored, indicating significant opportunities for future research.

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