

Trend Analysis of Principal Candidate Training Based on Scopus Data (2020–2024): Mapping Leadership, Digital Transformation, and Educational Innovation Using VOSviewer

R A Mustika Hariyanti ¹ , Agus Pahrudin ² , Muhammad Akmansyah ² , Ahmad Fauzan ² 

¹ Loka Diklat Keagamaan Bandar Lampung, Indonesia

² Universitas Islam Negeri (UIN) Raden Intan Lampung, Indonesia

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ABSTRACT

This study aims to analyze trends in scientific publications on principal candidate training using Scopus-indexed data from 2020 to 2024, employing a bibliometric approach supported by VOSviewer. The analyzed articles were selected based on the following relevance criteria: (1) indexed in Scopus, (2) published between 2020 and 2024, (3) directly discussing principal candidate training, educational leadership, or principal competency development, and (4) related to leadership transformation and educational innovation. This study was motivated by the growing need to strengthen school leadership competencies in the era of digital transformation and by the limited number of bibliometric studies that specifically map the development of research on principal candidate training. The research employed a qualitative descriptive method combined with bibliometric analysis. Data were collected using the Publish or Perish application integrated with the Scopus database, with keywords related to principal candidate training, school leadership training, and educational leadership development. The article selection process resulted in 20 publications that met the inclusion criteria. The findings indicate that publication trends have increased significantly since 2021, with major research focuses on transformational leadership development, managerial competencies, the effectiveness of principal training programs, and the integration of digital transformation in educational leadership. The VOSviewer analysis identified four major clusters demonstrating relationships among leadership style, transformational leadership, school leadership, candidate principals, school counsellors, and supervisors. The study reveals a shift in research orientation from traditional administrative leadership to innovative, technology-based educational leadership in the era of the Industrial Revolution 4.0. This research contributes theoretically to strengthening the mapping of educational leadership studies and serves as a strategic reference for developing future principal candidate training programs.

Corresponding Author:

R A Mustika Hariyanti

Loka Diklat Keagamaan Bandar Lampung, Indonesia

Letkol H. Endro Suratmin Street, Korpri Jaya, Sukarame 35131, Bandar Lampung, Indonesia

✉ mustikayanti095@gmail.com



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INTRODUCTION

The role of the principal, as the spearhead of a school's continuous progress reflected in both managerial processes and learning activities, is highly significant. However, the limited number of

principals with competencies that meet established standards indicates disparities within schools. These disparities can be addressed through an effective initial recruitment process. Principal leadership involves creating an environment that supports growth, self-renewal, and development, as well as distributing leadership throughout the school organization (Arif, 2024; Roja & Salim, 2023). Effective principal leadership is essential for improving teacher performance, as it greatly influences the quality of education (Hanim et al., 2020; Sari et al., 2021). Principals bear substantial responsibility within educational organizations and must lead effectively to ensure optimal institutional performance. School principals are expected to possess strong character traits that benefit the school and enable them to manage change effectively in the industrial environment. Effective school leaders are also capable of enhancing teacher performance through capacity-building programs for educators.

According to Regulation No. 7327/B.B1/HK.03.01/2023 of the Director General of Teachers and Education Personnel, the technical competencies of school principals encompass personal, social, and professional competencies. These competencies serve as the foundation for developing educational leadership oriented toward improving the quality of learning, fostering social collaboration, and strengthening a student-centered learning culture. In the era of the Industrial Revolution 4.0, school leadership must adapt to technological advancements, as these developments significantly influence school quality in responding to contemporary changes (Ripai et al., 2024; Rahayuningsih & Iskandar, 2022). Improving educational quality in the Industrial Revolution 4.0 era relies heavily on the crucial role of school leadership within educational institutions, where effective and efficient leadership is essential. School principals are required to understand their duties and functions comprehensively. Principal training programs are designed to enhance both current and future leadership skills. Principals are provided with comprehensive resources to improve school effectiveness, particularly in their roles as instructional leaders. Four core competencies of instructional leadership for school principals include: (1) leading the development of a student-centered learning environment, (2) leading the planning and implementation of student-centered learning processes, (3) leading reflection and continuous improvement in the quality of learning processes, and (4) involving parents or guardians as learning partners and educational resources within the school environment (Regulation of the Director General of Teachers and Education Personnel, Ministry of Education and Culture No. 6565/B/GT/2020). Previous studies on school principals indicate that effective school leadership is not only responsible for administrative duties (Rohman, 2021; Syahputra et al., 2023) but also capable of cultivating an environment that encourages learning, innovation, and value creation (Arif, 2024). Furthermore, the effectiveness of school leadership significantly influences various aspects of school life, including teacher performance, student learning outcomes, and overall school effectiveness. Effective school leadership is widely recognized as a critical factor influencing school success.

The effectiveness of school leadership significantly predicts internal efficiency in public secondary schools, particularly within underserved communities. The study found that leadership and management training directly enhances principals' competencies, thereby improving the overall quality of education. The importance of leadership in education is further emphasized through a deductive thematic analysis of educational leadership styles in Indonesian schools, which illustrates the crucial role of leadership in influencing educational outcomes.

According to Tanjung et al. (2025), there are significant differences in leadership styles between public and private secondary schools, indicating that the operational context of school principals substantially influences their leadership approaches. The complexity and demands of school leadership require specialized training programs to adequately prepare principals to face these challenges. Solechan et al. (2023) highlighted the importance of developing leadership training programs to improve the quality of school management. Such programs should emphasize not only administrative skills but also the development of leadership qualities that foster a positive school environment and support educational success. A study conducted by Arifah (2025) examined the leadership strategies employed by school principals to enhance the quality of "link and match" in vocational education, emphasizing the need for training programs tailored to the diverse requirements of different educational contexts.

Research by [Herman et al. \(2025\)](#) demonstrated that principals' leadership practices significantly improve school quality and students' learning outcomes. The findings identified effective educational strategies for preparing competent and professional school leaders. Strengthening the professional development of school leaders, therefore, requires greater research attention. [Rijal et al. \(2025\)](#) found that the education and training program for prospective principals at the Educational Quality Assurance Institution of East Java Province was implemented effectively and efficiently. Previous research by [Waruwu et al. \(2021\)](#) found that community service activities enhanced the managerial, supervisory, and entrepreneurial competencies of prospective principals at Christian educational institutions in Salatiga City.

The research gap in this study encompasses three main aspects. First, the methodological gap, namely, the limited number of studies employing a VOSviewer-based bibliometric approach to analyze research trends in prospective principal training. Second, the thematic gap, reflected in the shift of research focus from traditional administrative leadership toward digital transformation-based leadership and educational innovation, which has not yet been systematically mapped. Third, the geographical gap, reflected in the dominance of studies from certain countries, results in the absence of a comprehensive global perspective on the development of educational leadership studies.

Based on these gaps, this study aims to: (1) analyze scientific publication trends related to prospective principal training in the Scopus database during the 2020–2024 period; (2) map the relationships among topics, keywords, and research networks using VOSviewer; and (3) identify the development of research themes related to educational leadership, principal competencies, and digital transformation in prospective principal training.

The novelty of this study lies in integrating leadership and transformation perspectives. More specifically, this research contributes by combining bibliometric analysis with the mapping of digitally driven educational leadership transformation in prospective principal training. The study demonstrates a shift in research orientation from the development of administrative leadership toward innovative, technology-oriented leadership and digital transformation in the era of modern education.

METHOD

This study employed a qualitative descriptive method, complemented by bibliometric analysis, to elaborate on the data. The research began with the collection of scientific publications on principal candidate training from various reputable online sources. Subsequently, a screening and verification process was conducted to ensure that the selected articles were published in Scopus-indexed journals within the 2020-2024 period. The data were derived from journals discussing training programs for school principals. The researchers utilized reference management software, namely Publish or Perish, for data collection. This program enabled the selection of relevant articles and journal data from Scopus. Publish or Perish also facilitated the literature review process on the selected theme. An analog research database was then developed.

This study used the Scopus database, with relevant journals covering the most recent five-year period, from 2020 to 2024. The inclusion criteria in this study were as follows: (1) articles indexed in Scopus; (2) articles published between 2020 and 2024; (3) articles directly related to principal candidate training, school leadership, or principal competency development; and (4) articles available as complete scientific publications. Meanwhile, articles that were not relevant to the theme of educational leadership or did not substantively discuss principal training were excluded from the analysis process.

The collected data were subsequently imported into VOSviewer. The data were processed and aligned with the predetermined keywords. Furthermore, VOSviewer transformed the input data into interconnected information networks. This analysis examined annual fluctuations in the number of publications and categorized the findings accordingly. Based on the selection process, 20 articles met the analysis criteria. The relatively limited number of articles was due to the narrow scope of the research theme, which specifically focused on principal candidate training and digitally based educational leadership transformation.

RESULTS AND DISCUSSION

Based on the results of the bibliometric analysis, the total number of citations from the 20 articles was 50, with an average of 2.5 citations per article. An h-index value of 13 indicates that 13

articles have consistently received citations in other scholarly publications. Meanwhile, a g-index value of 18 reflects a relatively strong academic impact of the analyzed articles. These findings demonstrate that studies on principal candidate training have begun to attract significant academic attention, particularly in the context of educational leadership development in the era of digital transformation.

Table 1. Publication data related to the principal candidate training program

Citation	Author	Title	Year	Source
15	Lenarz, T., Büchner, A., & Illg, A.	Cochlear Implantation: Concept, Results Outcomes and Quality of Life. .	2022	Laryngo-Rhino-Otologie, 101(S 01), S36-S78
9	Drake, T. A., Ivey, L., & Seaton, L.	Principal candidates' reflective learning during a full-time internship	2023	Journal of Research on Leadership Education, 18(2), 207-227.
7	Shehhi, M. Al (2020).	An examination of the emotional intelligence of school principals and the impact on school climate in public schools in the United Arab Emirates	2020	Journal of Applied Research in Higher Education, 13(5), 1269-1289, ISSN 2050-7003, https://doi.org/10.1108/JARHE-09-2020-0287
5	Campos- García, I.	Strategic decision- making in secondary schools: the impact of a principal's demographic profile.	2022	Leadership and Policy in Schools, 21(3), 543-564, ISSN 1570-0763, https://doi.org/10.1080/15700763.2020.1802653
4	Lawrence, A.	Principals' Perceptions of Transformed School Counselors.	2019	NASSP Bulletin, 103(2), 139-157, ISSN 0192-6365, https://doi.org/10.1177/0192636519853029

Topic Area Visualization of Principal Training Programs Using VOSviewer

Computational mapping was conducted using article data. VOSviewer was used to perform the computational mapping. The computer-based mapping results identified numerous entries. Each item related to spiritual leadership in the data mapping was categorized into four clusters, namely:

Cluster 1: leader, leadership style, principal leadership, school leadership, transformational leadership.

Cluster 2: candidate, principal.

Cluster 3: school counselor, supervisor.

Cluster 4: school principal leadership.

The relationship among the elements is illustrated within the existing clusters. Each phrase is labeled and represented by a colored circle. The diameter of each cluster circle varies according to the frequency of the cluster's occurrence. The more frequently a term appears, the larger its label becomes. The mapping visualization examined in this study consists of three components: network visualization (see Figure 1), density visualization (see Figure 2), and overlay visualization (see Figure 3). Figure 1 illustrates the correlation among terms, with relationships between concepts

represented as interconnected networks. Figure 2 illustrates clusters of terms that are frequently investigated in relation to the projected research topic on principal training programs.

The network visualization reveals that research on prospective principal training programs consists of four clusters, displaying 19 links with a total link strength of 98. Meanwhile, the density visualization indicates that the terms leadership, principal leadership, and transformational leadership appear in the brightest colors. This suggests that these three themes are the most dominant and most frequently researched topics in studies concerning prospective principal training programs.

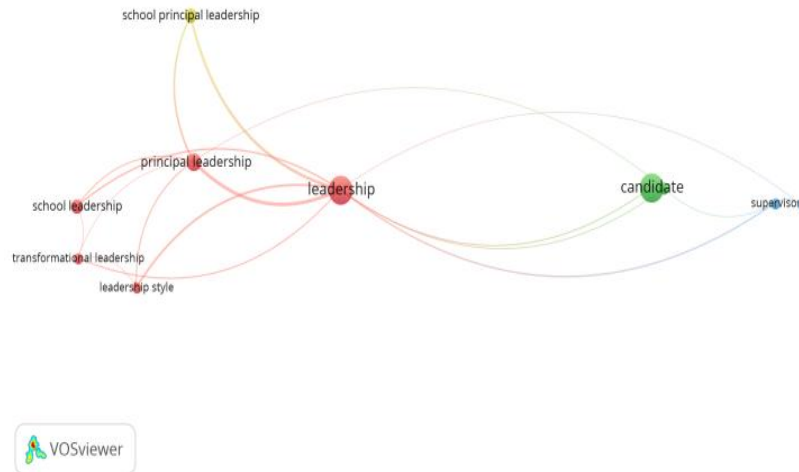


Figure 1. Network visualization

Figure 2 illustrates a density visualization. The density visualization indicates that brighter yellow tones and larger word-label circle diameters are associated with a higher frequency of phrase occurrences in the research. This suggests that numerous studies related to these terms have been conducted. Conversely, when the term colors fade toward the background hue, it indicates that research on those terms remains limited.

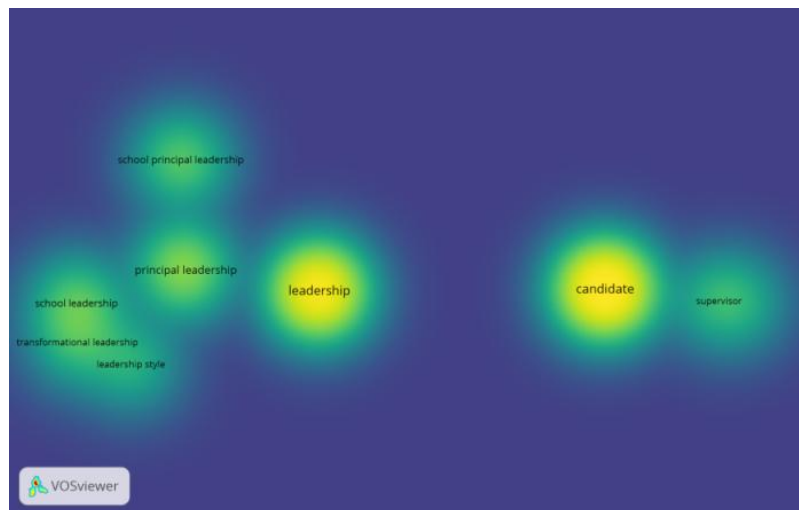


Figure 2. Density visualization

Figure 3 illustrates the overlay visualization of anticipated principal training programs. This graphical overlay depicts the quantity of research innovations associated with interconnected phrases. Figure 3 shows that extensive studies on anticipated principal training programs were conducted between 2020 and 2024. The term “principal training” has been widely explored across various fields and topics over a considerable period of time. Consequently, this term offers substantial opportunities to conduct new studies on potential principal training programs.

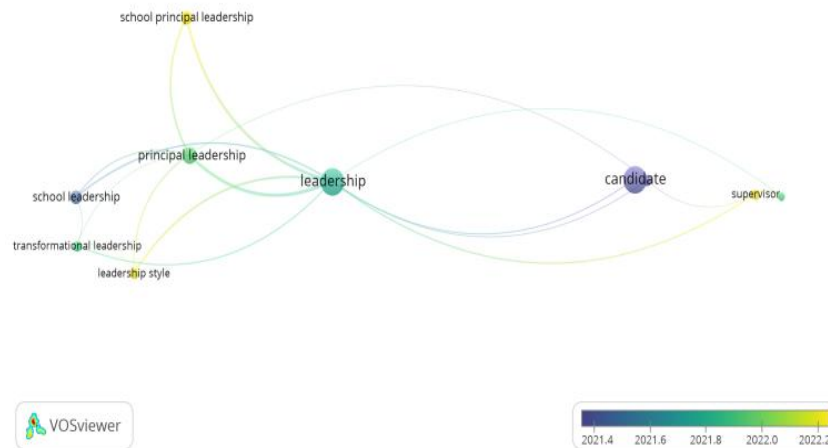


Figure 3. Overlay visualization

Data analysis of 20 Scopus-indexed articles indicates that the keyword “principal training” has been extensively studied, as evidenced by the substantial number of publications published annually. The findings of this study highlight a more advanced and contemporary approach to prospective principal training, with significant implications for institutional development and the overall effectiveness of educational programs. School principals are expected to recognize that effective school leadership requires both quality and competence. Prospective principal training programs represent a leadership approach designed to motivate and inspire both leaders and their followers.

The effectiveness of school principals in improving the quality of education is intrinsically linked to their competence and ability to fulfill their responsibilities and functions. The purpose of training and educational programs for principals is to enhance their competencies in relation to their duties and roles, while also motivating them to establish autonomous schools that can improve student learning outcomes and promote student well-being. The position of principal requires specialized professional competencies associated with specific operational responsibilities. These competencies are both theoretical and practical. In addition, there are behavioral competencies related to attitudes and values that are beneficial within the role's functional framework. Competency standards are designed to guide the initial training of prospective principals and to facilitate the acquisition of essential skills; therefore, both professional and behavioral competencies are expected to support the key functions outlined in the standards.

Therefore, it is essential to equip school principals with appropriate training to engage in these complex responsibilities through well-structured programs. Programs designed to help principals develop into instructional leaders and positively influence student achievement remain insufficient in various respects. Explicit commitment and intention, academic standards, professional goals, and prior experiences demonstrating individual leadership capabilities should serve as more rigorous selection criteria. Integrating learning into pre-service principal training presents a promising avenue for further exploration. This study represents an initial effort to provide guidance for practitioners, researchers, and policymakers in enhancing principal training development. Its objective is to strengthen existing capacities, address identified shortcomings, minimize potential risks, and capitalize on available opportunities. By examining diverse training methodologies, pre-service professional development programs can help formulate effective training frameworks for prospective school principals.

Findings by [Jannah \(2021\)](#) indicate that school principals play a crucial role as leaders in teachers' professional development, which is essential for maintaining high educational standards. Extensive documentation has demonstrated the correlation between effective leadership and school improvement. Research by [Caayaman \(2023\)](#) examining the mentoring and monitoring practices of school supervisors found a significant influence on principals' effectiveness. Furthermore, [Maria Noureen et al. \(2020\)](#) investigated the impact of leadership characteristics on school improvement in Azad Jammu and Kashmir, emphasizing the vital role of leadership in enhancing educational outcomes. [Hasan's study \(2022\)](#) highlighted the importance of principals and teachers as agents of change within schools, advocating for leadership training that empowers them to initiate and sustain

school improvement. This is particularly important in developing countries, where resources are often limited, and the challenges faced by school leaders are more pronounced (Hasan, 2022).

The principal possesses managerial competencies that encompass school planning, organization, coordination, and supervision. A principal is expected to manage interpersonal relationships, navigate complex situations, apply analytical and conceptual thinking, and serve as a mediator in decision-making processes. The principal's responsibilities include planning, organizing, motivating, and controlling all aspects of the school's resources. Collaboration among all staff members and stakeholders is essential to improving the quality of school management.

Educational leadership extends beyond local and regional contexts, presenting challenges on a global scale. The findings of Li dan Yan (2020) provide a critical analysis of four decades of educational reform in leadership preparation in China, highlighting the dynamic development of leadership training programs worldwide. The evolution of educational systems necessitates the development of adaptive, relevant leadership training programs tailored to the unique requirements of different countries and educational contexts (Li & Yan, 2020). According to Leithwood et al. (2020), school leadership is regarded as the most influential school-related factor affecting student achievement and growth, second only to classroom instruction and teacher quality. Furthermore, Drake (2022) reported that the effective integration of interns into schools and leadership teams during their clinical experiences positively impacts their knowledge, skills, dispositions, post-graduation career goals, and student performance in schools led by these graduates. Effective leadership enhances school performance and promotes the overall development of both teachers and students. The challenges faced by school principals are diverse and substantial, requiring targeted training programs that address the specific needs of educational leaders. This study aims to develop a training model to cultivate school principals who create value in education, thereby addressing a significant gap in the current literature on educational leadership.

In general, a comprehensive approach to leadership development for school principals is essential. Through a combination of training strategies, skill development, and conceptual understanding, participants are expected to become leaders well-prepared to navigate the dynamics and changes in the educational environment. By improving the quality of school principals' leadership, it is anticipated that overall school management will also improve, thereby positively impacting the quality of education provided in schools.

CONCLUSION

Based on a bibliometric analysis using VOSviewer of scientific publications on principal candidate training during the 2020–2024 period, it can be concluded that research in this field has experienced significant growth, particularly after 2021. The increase in publications indicates growing academic attention toward strengthening educational leadership and developing school principals' competencies in the era of digital transformation. The bibliometric mapping identified four major clusters, namely transformational leadership, principal candidate development, educational supervision, and school principal leadership. These clusters demonstrate that research on principal training is not only focused on administrative aspects, but also encompasses the development of educational innovation, academic supervision, and the strengthening of educational collaboration. This study also revealed a shift in research themes from traditional administrative leadership toward leadership grounded in digital transformation and educational innovation. These findings suggest that future school principals will need to possess adaptive competencies, change management skills, and digital leadership skills to address the challenges of modern education. Furthermore, bibliometric analysis assisted by VOSviewer is an effective approach for comprehensively identifying research patterns, relationships, and developmental trends. Therefore, the findings of this study may serve as a strategic reference for researchers, educational practitioners, and policymakers in designing more innovative and relevant principal candidate training programs that align with the demands of 21st-century education.

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