Natural Language Processing in School Management: A Systematic Literature Review Towards Developing an Adaptive Smart-Coaching Framework

Cucun Sunaengsih[1], Isrok'atun[2], Rita Anggorowati[3], Popon Rohaeti[4], Dadan Djuanda[5], Muthahharah Thahir[6], Laely Purnamasari[7]

[1,2,3,5]Elementary School Teacher Education Study Program, Universitas Pendidikan Indonesia, Sumedang, Indonesia
[4]Sumedang Regency Education Office, Sumedang, Indonesia
[6]Department of Guidance and Counseling, Faculty of Teacher Training and Education, Ma'soem University, Sumedang, Indonesia.
[7]Accounting Study Program, Faculty of Economics and Business, University of Informatics and Business Indonesia, Bandung, Indonesia

Corresponding author: cucunsunaengsih@upi.edu
Track: *[Track 1 — Primary Education]*

Abstract

The application of Natural Language Processing (NLP) in school management has become a revolutionary technique, particularly in elementary school administration. Even so, the number of frameworks that can integrate NLP capabilities with adaptive coaching systems specifically designed for improving school management effectiveness is still very limited. A literature review is conducted to map current research trends, identify thematic clusters, and synthesize existing knowledge towards developing an Adaptive Smart-Coaching Framework using NLP. The visualization of keyword co-occurrence networks from 847 relevant articles published between 2020 and 2025 is achieved through bibliometric analysis with VOSviewer. Three research clusters were identified: (1) core NLP technologies, such as LLM, BERT, transfer learning, and text classification; (2) social and educational AI systems; and (3) human-centered dimensions of learning and behavior. Despite its extensive use in healthcare and social media, the study suggests that NLP's application in elementary school management is still an unexplored field. This review presents an NLP-based approach to learning (NLP) that employs four components to aid principals in managerial decision-making, communication, staff development, and organizational effectiveness.

Keywords: *natural language processing; school management; adaptive smart-coaching; large language model; systematic literature review*

1. INTRODUCTION

Recent developments in Artificial Intelligence (AI) present substantial chances to improve how principals carry out their duties (i-e; their roles in schools). Effective leadership and management within elementary schools are crucial for boosting quality and enhancing student learning results (Sunaengsih et al., 2019). Who would deny that the principal's job has grown more complicated requiring sophisticated tools that can examine large data sets and tackle new administrative issues?

An intelligent coaching platform combines Artificial Intelligence (AI) to deliver custom support (i.e. personalized guidance). Utilizing Natural Language Processing (NLP) allows this Artificial Intelligence (AI) technology to understand individual issues presented by a principal using everyday language which leads to customized recommendations. Leaders gain help in steering through contemporary education settings thanks to Natural Language Processing (NLP). Although Artificial Intelligence (AI) holds significant potential a

cohesive system tailored to elementary school management is not yet accessible. Further advancement of these tools remains crucial to aid the vital tasks undertaken by school leaders.

Research patterns are effectively illustrated through a bibliometric analysis using VOSviewer (which offers detailed insights). Three main clusters emerge from this examination related to NLP and education. Notably these clusters indicate a promising opportunity to develop integrated systems that connect technological organizational and instructional factors in school settings.

Three research questions are explored in the study. First dominant themes and research clusters in NLP-focused school management literature from 2020 to 2025 are identified (i-e; studies on trends). Second necessary theoretical and empirical foundations to back an NLP-based Adaptive Smart-Coaching Framework for elementary school management are analyzed. Lastly a conceptual framework is introduced built from compiled evidence.

Research on NLP technology is crucial given its link to the real-world needs of elementary school principals (i.e.; practical use). Advancements occur in academic insights concerning the application of NLP in educational management. Incorporating NLP showcases its significance in contemporary school environments. Moreover the investigation underscores NLP's impact on the development of administrative tools in today's digital age.

2. METHODS

This research is based on the systematic literature review (SLR), which is oriented on the use of previous studies in the investigation of the relevant topics. The study is done in accordance with PRISMA checklist. The research is done in four stages: (1) Literature search, (2) Screening for eligibility of sources, (3) Mapping the connections of ideas in VOSviewer, (4) Identifying the key aspects of the research.

2.1 Literature Search Strategy

The authors conducted the search using different authoritative sources, including print and online databases (Scopus, Web of Science, Google Scholar, ERIC) in the period of 2020-2025. The search resulted from the three key criteria: (1) NLP Technology: natural language processing, large language models, BERT, text categorization; (2) The area of School Management: school administration, leadership of principals, management in education, coaching; (3) Adaptive Systems: adaptive learning, smart coaching, AI-based education.

2.2 Inclusion and Exclusion Criteria

According to the results of the findings, the articles were considered suitable in terms of (1) the publication date being in 2020-2025 in high-ranked journals; (2) the research being dedicated to the use of NLP and AI technologies in education; (3) the language being either English or Indonesian; (4) the article being significant for understanding the aspects of school management or adaptive learning. We do not select articles that: (1) Only focus on the use of NLP outside the field of education; (2) Have not undergone a feasibility check by other researchers (peer-review); (3) Lack of clarity in explaining the method.

2.3 Bibliometric Analysis and PRISMA Flow

By using VOSviewer, we were able to identify the connections between essential concepts in 847 pertinent articles. We narrowed down the first 1,240 articles into detailed analysis of 54. PRISMA filtering is outlined in Table 1.

Table 1. Tests of Normality

Stage	Number of Articles (n)	Action / Description
Identification	1,240	Database search: Scopus, WoS, Google Scholar, ERIC (2020–2025)
Filtering	893	Title & abstract filtering; duplicate removal
Eligibility	312	Full text review based on inclusion/exclusion criteria

Processed by VOSviewer	847	Articles processed in VOSviewer bibliometric analysis
Final synthesis	54	Articles included in the thematic synthesis and framework development

2.4 Data Synthesis

Researchers analyzed the selected articles using Thomas and Harden's (2008) three-stage approach: (1) Marking the key findings of each article; (2) Grouping the findings into themes; (3) Developing major themes that became the basis for our systems thinking.

3. RESULTS AND DISCUSSION

3.1 Bibliometric Mapping: Three Thematic Clusters

Figure 1 displays the bibliometric map of three significant research topics that the researchers examined using VOSviewer. The analysis of this review is based on the cluster

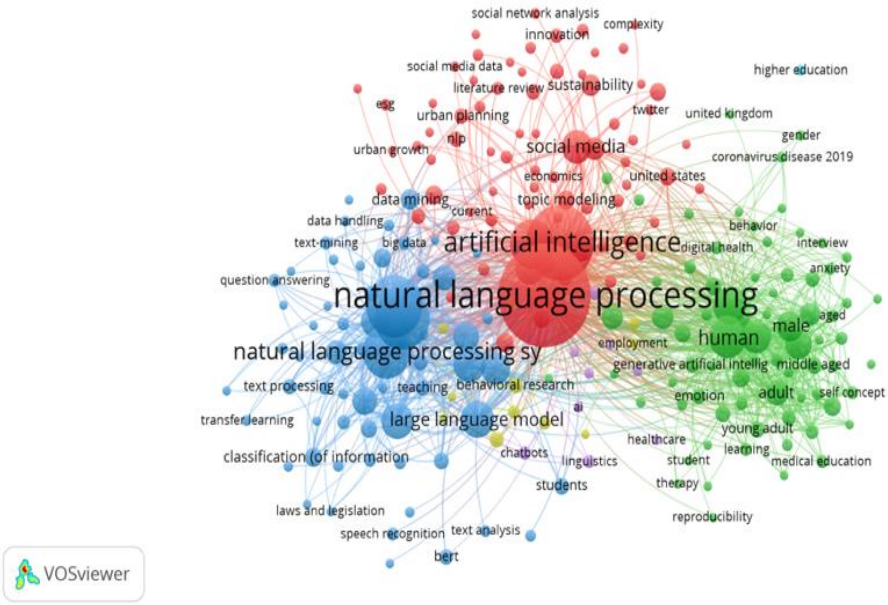

Figure 1. VOSviewer Keyword Co-emergence Network Map: NLP in School Management (2020–2025)

Core NLP technologies, such as NLM, BERT, transfer learning, text classification and speech recognition are in cluster 1, (blue). It is the technical basis for many areas, including education. The second cluster, in red color, is dedicated to educational AI and social systems, including AI, topic modeling (both positive and negative), social media analysis, data handling, and network analysis. Cluster 3, in green, signifies human-centered learning and behavior, which includes humans, behavioral research, learning, medical education, emotions (including depression), and generative AI. In terms of NLP-based management research, the convergence zone is where the three clusters' convergence lies, specifically in the domains of "generative artificial intelligence," "behavioral recherche," and "learning.".

Table 2 summarizes the three identified clusters along with representative keywords and their relevance to the proposed research framework.

Table 2. Research Clusters from VOSviewer Bibliometric Analysis

Cluster	Color / Label	Main Keywords
1	Blue – NLP Core Technology	NLP, LLM, BERT, transfer learning, classification, text processing, speech recognition, Q&A

2	Red – AI & Socio-Educational Systems	Artificial intelligence, topic modeling, social media, data handling, social network analysis, urban planning
3	Green – Human-Centered Learning & Behavior	Humans, behavioral research, learning, emotions, generative AI, healthcare, medical education, self-concept

3.2 Thematic Synthesis: Application of NLP in School Management

Thematic synthesis of 54 articles identified five main themes related to the application of NLP in school management.

The first theme is the Automation of Administrative Work, in which computers can automate routine work by principals: filing paperwork and creating reports as well as managing communications (Zawacki-Richter et al., 2021; Chen et al., 2022). This allows principals to have more time for strategic leadership and education planning. This application decreases the principal's cognitive burden and empowers humans to take charge of strategic leadership, which in turn supports management effectiveness (Sunaengsih et al, 2019).

Theme 2 is composed of Adaptive Feedback and Guidance Systems that utilize NLP to analyze principals' communication styles, identify challenges they confront, and offer guidance for specific situations. In particular, it helps improve leadership and communication skills as well as staff management skills (Dai et al., 2023; Kim et al., 2012), p.

In Theme 3: Sentiment Analysis and Behavioral Understanding, NLP can be applied to investigate the emotions and perspectives of teachers as well as school staff regarding various issues. By being cognizant of the emotional state and needs of their team, principals can make more informed decisions and create a more productive work environment (Aldowah et al, 2020; Okoye & Associates, 2023).

Large language models, such as GPT, can be utilized in education to provide guidance and recommendations for dealing with complex administrative tasks, as discussed in theme 4. This helps improve managerial decision-making (Kasneci et al., 2023).

Human-Centered Artificial Intelligence, which is the fifth theme, emphasizes the importance of designing AI systems to meet human users' needs and behaviors. Luckin et al. state that systems must be accessible, relevant, and ethical in nature (Luckin et al., 2022).

3.3 Proposed NLP-Based Adaptive Smart-Coaching Framework (NLP-ASC)

Based on the evidence we have collected and examined, we propose an NLP-Based Adaptive Intelligent Coaching System that includes four main components:

Component 1. An engine that integrates pre-trained transformer models (BERT, GPT) fine-granular on a school management corpus to enable text classification, sentiment analysis and features like named entity recognition with the generative response capabilities is the NLP Processing Engine.

Component 2: Adaptive Coaching Module provides tailored coaching advice using the output of an NLP engine. Depending on the principal's profile and previous interactions, this module can be modified to accommodate various types of challenges they encounter. This module encompasses four primary functions: supporting decision-making, facilitating effective communication, leading staff development, and assisting in solving management problems (Sunaengsih et al, 2019).

The School Management Knowledge Base's third component is a comprehensive school management knowledge base that includes current research, educational policies, and best practices in elementary school administration. This is an integrated learning experience. NLP can be used to update the knowledge base by automatically extracting information from new scientific literature.

This component ensures that the system is easy to understand and use for principals. Component 4: Human-Centered Interface. The system is unambiguous, presenting the reasons for every suggestion, permits principals to provide evaluations on their suggestions' quality, and can be adjusted to meet user needs. This

section outlines design principles that emphasize the importance of human beings rather than technology (Holmes et al, 2022).

This system is not intended to replace the role of principals, but rather to empower them. An approach to improve the skills and experience of principals in leading, managing and promoting Indonesian schools is provided by NLP technology (Sunaengsih et al, 2019), as well as research on principal leadership in elementary school education in Indonesia (Tamam et al., 2020; Komariah et al., 2021; Thahir et al., 2021).

3.4 Implications for Elementary School Management

Our proposed NLP-ASC system provides principals with a coaching tool that's scientifically proven, easily accessible, and quantifiable. This issue is particularly relevant in Indonesia, where numerous principals are still lacking management training, especially those who hold concurrent positions or are facing new leadership challenges (Zidane Ardiansyah et al., 2023), and lacking leadership capacity during the COVID-19 outbreak (Thahir et al., 2021).

The Indonesian government's plan to transform education through digital technology and data- and research-based management decisions is supported by this system from an education policy perspective. More testing will be required to test this system in real-world schools and see whether it actually makes school management more efficient.

4. CONCLUSION

This systematic literature review uses bibliometrics to map the current landscape of NLP research in school management and has identified three major thematic clusters: core (LP) technologies, socio-educational AI systems, and human-centered behavioral learning. The amalgamation of these three clusters revealed a significant research shortcoming in the application of NLP-based adaptive coaching to elementary school management. The proposal in this paper is to create an NLP-Based Adaptive Smart-Coaching Framework (NLP–ASC) that comprises four integrated components, including an Industrial Processor and the Sensory Processing Engine with built-in functions. By utilizing LLM, transfer learning, and sentiment analysis, this framework offers evidence-based personalized coaching for school principals, offering theoretical insights and practical implementation in elementary school management. Further empirical studies are recommended to support and validate this framework across a range of educational contexts.

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