Article

DEVELOPMENT OF EDUCATIONAL INNOVATION 4.0: CREATING AN INFORMATION TECHNOLOGY LEADERSHIP FRAMEWORK FOR PRIMARY AND SECONDARY SCHOOL PRINCIPALS IN LIAONING PROVINCE*

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Abstract

The era of Educational Innovation 4.0 has brought significant transformations to the education system. These changes have not only reshaped teaching and learning methods but have also directly impacted how school leaders manage educational institutions. Over the past decades, advancements in Information Technology (IT) have become a key factor influencing various aspects of school administration, particularly at the primary and secondary levels.

The role of school principals in the 4.0 era has evolved from a focus on academic administration to becoming leaders who can effectively integrate technology into strategic planning, resource management, and creating a conducive learning environment for both teachers and students. Therefore,

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establishing an IT leadership framework is essential for primary and secondary school principals, particularly within the context of Liaoning Province.

This IT leadership framework for school administrators in the 4.0 era should encompass the ability to leverage technology to enhance operational processes and improve teaching and learning. Additionally, it should foster a deep understanding of using technology efficiently, emphasizing the development of technological skills, data management, data analysis for decision-making, and promoting an organizational culture that supports flexible learning and rapid adaptation to change.

Liaoning Province, a region undergoing rapid economic and social transformation, requires the development of an IT leadership framework for school principals to ensure that the education system responds effectively to the needs and challenges of the digital age. By presenting this leadership framework, we aim to enhance the capacity of school leaders to manage education in the 4.0 era with efficiency and sustainability.

Keywords: Education 4.0 Information Technology Leadership, Innovative Development of Education Informatization, Innovative Integration of Technology and Teaching, Artificial Intelligence+Education

Introduction

The arrival of the Education 4.0 era signals the need for innovative educational development to prioritize the integration of information technology as both a core component and a primary pathway. The framework proposed in this article seeks to address the challenges of advancing educational innovation by focusing on the role of principals as leaders in information technology. Through their leadership in driving IT innovation, principals can propel the

development of Education 4.0, fostering the cultivation of a new generation of innovative talents capable of thriving in the intelligent era.

To achieve this, the framework centers on the integration of information technology with teaching innovation, particularly in the context of Education 4.0. It outlines four major levels through which principals can realize their leadership roles: the planning system, school system, teaching system, and personal system. Drawing on the work of Lin, Shyu, and Ding (2017), this comprehensive and systematic approach spans from macro to micro levels, presenting an information-based leadership framework tailored to the innovative development of primary and secondary school principals in the 4.0 era. This framework offers a valuable reference for the design and development of standards for principals' information leadership, including training programs, activities, and assessment tools. It can also support initiatives aimed at improving the application of information technology among primary and secondary school teachers. However, educational informatization is a complex, evolving, and systematic undertaking. While this framework has undergone practical testing and revision through two rounds of iterative open surveys involving school principals, the sample size was limited. As such, the framework's effectiveness requires further validation, particularly in relation to different types of schools. Long-term testing and subsequent revision and improvement are necessary.

Moving forward, the continued refinement and enhancement of this framework should be a key focus of future research within the context of Educational Informatization 2.0, as noted by Zhao, Zhao, and Shi (2023).

Content

Principal Information Leadership Framework from the Perspective of Education 4.0: Research Background and Significance In January 2020, the World

Economic Forum released a pivotal report titled "Schools of the Future: Defining a New Education Model for the Fourth Industrial Revolution." This report outlined a global framework for Education 4.0, which prioritizes innovative approaches to education in response to the rapid changes brought on by the Fourth Industrial Revolution. At the educational goals level, the framework emphasizes the cultivation of essential skills such as global citizenship, innovation and creativity, technical expertise, and interpersonal communication. On the learning side, it advocates for personalized and autonomous learning, inclusive and barrier-free education, problem-solving and collaborative learning, lifelong education, and student-centered initiatives. Meanwhile, at the teaching level, the report promotes innovative instructional methods, including game-based learning, experiential teaching, computer-aided learning, and multicultural education.

This framework signifies that global education in the intelligent era, aligned with the advancements of the Fourth Industrial Revolution, has now entered the Education 4.0 phase. The innovative development toward Education 4.0 is poised to become a global trend and a critical component of education reform. In recent years, Education Informatization 2.0, increasingly driven and influenced by intelligent technology, has become a key pathway and driver for the innovative development of Education 4.0. In recognition of this, China launched the Education Informatization 2.0 Action Plan in 2018 to realize these advancements in education.

Education Informatization 2.0 and Education 4.0 share a complementary relationship, particularly in their training goals, content, and implementation methods for the intelligent era. China's 25-year history in promoting educational informatization has seen significant progress. The initial phase, Education Informatization 1.0, focused on the construction and application of educational informatization, driven by initiatives such as the Three Communications and

Two Platforms. This phase successfully integrated information technology into education and teaching, achieving the historical goals set for Informatization 1.0. However, despite these achievements, the transformative potential of information technology in enhancing education—particularly in developing higher-order thinking skills and cultivating innovative talents for the intelligent era—remains underutilized. Consequently, Education Informatization 2.0 must align with the global framework of Education 4.0 to continuously foster innovation across all levels and types of education. This alignment has become an essential mission of the intelligent era. With the forthcoming release of the 14th Five-Year Plan, the year 2020 marks a critical juncture for the innovative development of Education 4.0 in China, bridging past achievements with future progress in educational informatization. This trajectory is expected to have a profound and positive impact on the future of education in China, ensuring that the country remains at the forefront of global educational innovation in the intelligent era.

Promoting the Innovative Development of Education Informatization 2.0 and Education 4.0: The Role of Principals in School-Level Implementation

To advance the innovative development of Education Informatization 2.0 and Education 4.0, it is imperative that these initiatives move beyond top-level design and are implemented effectively at the school level. This is especially true for the innovative application and practical exploration of information technology in primary and secondary school teaching. The innovative development of informatization within schools is a critical driver of teaching innovation. Without innovation in school-level informatization, achieving meaningful and sustainable progress in teaching innovation is unlikely, and any gains made may be short-lived . Undoubtedly, in primary and secondary schools, the principal plays a pivotal role as the driving force behind the innovation and development of school informatization. The principal's leadership in advancing the goals of Education 4.0 and fostering the growth of

informatization is crucial for the successful and sustainable implementation of these innovations within the school system. Recognizing this, the Ministry of Education launched the Primary and Secondary School Teachers' Information Technology Application Ability Improvement Project 2.0 in 2019. This project aims to provide comprehensive training for principals and teachers in innovative information technology skills, underscoring the importance of strong leadership in driving educational transformation.

Despite the growing body of research on education informatization, school-level informatization, and teacher informatization, studies that specifically address the framework for information leadership remain limited, both domestically and internationally. In particular, the development of an information leadership framework tailored to primary and secondary school principals in China has yet to be fully explored. This gap highlights the need for further discussion and research, which carries significant theoretical and practical value for advancing education in the digital age (Zhuang & Liu, 2022).

1.2 Overview of Related Content

The interconnection between Education 4.0, the stages of educational informatization development, the project to enhance the information technology application abilities of primary and secondary school teachers, and the construction of an information leadership framework for school principals is evident. As depicted in the accompanying figure, the development of educational informatization has evolved through several stages—construction, application, and integration—and has now entered the innovative development phase characteristic of the Education 4.0 era.

Future research on principals' information-based leadership in China will inevitably need to align with the innovative demands of Education 4.0. This entails constructing and exploring a robust information leadership framework for school principals, which will empower them to lead the innovative

development of school informatization. Principals' information leadership serves as the foundation for uniting and guiding school administrators, IT staff, teachers, and students in effectively applying information technology to transform educational practices. Moreover, it is essential for fostering key competencies among students, including innovation and creativity, global digital citizenship, collaboration, communication, independent learning, digital and intelligent literacy, emotional intelligence, and complex problem-solving skills. These competencies are crucial for students to thrive in an intelligent society, enabling them to adapt to learning, life, and work in a rapidly evolving digital world.

The exploration of an information leadership framework for principals in the context of the innovative development of Education 4.0 is a vital and contemporary area of study. As school informatization transitions from the initial stages of construction and application to a more integrated phase, the emphasis has increasingly shifted toward teaching. However, current research by scholars like Meng and Wang (2017) primarily focuses on models of principals' leadership during the integration of informatization, rather than on a leadership model tailored to the innovative development needs of the Education 4.0 era. This gap underscores the need for further investigation into the information leadership frameworks that can drive schools toward innovation in the digital age.

2. The Connotation of Education 4.0 Information Innovation and Development and the Principal’s Information Leadership

2.1 The Connotation of Education 4.0 Innovation and Development

The development of educational informatization can be categorized into four stages: construction, application, integration, and innovation. These stages reflect the corresponding evolution of integrating information technology with teaching. The innovative development of Education 4.0's informatization represents the culmination of this progression, emphasizing the seamless

integration of information technology with teaching innovation. This process aims to achieve a holistic fusion of these elements in order to meet the educational demands of the intelligent era (Zhuang & Liu, 2022).

To define the innovative development of Education 4.0's informatization, it is crucial to understand the relationship between information technology and teaching innovation. The essence of this integration in the Education 4.0 era is threefold: it involves fostering talent for the intelligent era, adhering to a teaching philosophy that empowers students, and employing student-centered teaching methods.

From the perspective of talent development, the integration of information technology and teaching innovation is not an end in itself. The ultimate goal is to cultivate a generation of innovative talents capable of thriving in an intelligent society. As artificial intelligence advances, machines will increasingly replace humans in performing routine, repetitive, and calculable tasks, liberating people to engage in more creative and intellectually demanding activities. Consequently, future students must be equipped with the ability to identify, analyze, and solve complex problems—key skills that will be essential in a rapidly evolving intelligent society.

From a pedagogical standpoint, developing students' higher-order thinking skills requires that they take an active role in their own learning. Research indicates that independent learning, innovation, critical thinking, and other advanced cognitive abilities emerge from students' active engagement and self-directed development. Therefore, teaching methods that empower students to learn must be student-centered, focusing on stimulating their intrinsic motivation. These methods might include project-based learning, task-driven approaches, and experiential teaching. The specific strategies can be tailored to suit subject matter, students' cognitive characteristics, and the available technological infrastructure. Ultimately, the goal is to allow students

autonomy in setting learning goals, choosing learning strategies, and demonstrating their learning outcomes.

In summary, the innovative development of information technology in Education 4.0 is geared toward cultivating innovative talents for the intelligent era. It embraces a teaching philosophy that empowers students to take control of their own learning, using student-centered methodologies to continually drive the integration of information technology and teaching innovation. Throughout this process, various elements of a school's infrastructure, including its vision for information technology innovation, strategic planning, coordination of interests, infrastructure, teaching resources, and innovation teams, must be aligned to foster an integrated pattern of information innovation and development. Such a coordinated approach provides the foundation for innovative collaboration and support within educational institutions (Wang, Chaisirithanya, & Chinatangkul, 2022).

2.2 Principals' Information Leadership Behaviors in the Development of Education 4.0 Information Innovation

Building on the analysis of the elements and processes of Education 4.0 informatization innovation and development, it becomes evident that principals' leadership behavior in the context of informatization is crucial. Specifically, their leadership is reflected in four key areas: the creation of innovative development plans for school informatization, the transformation of systems to support informatization innovation, leadership in the reform of informatization-driven teaching, and taking proactive steps in the development of informatization. These aspects are critical in guiding the innovation and development of school informatization.

Strategic Planning: Principals must develop comprehensive and forward-looking plans for the innovative development of school information technology. These plans should align with the broader goals of Education 4.0

and include strategies for integrating information technology into teaching and learning practices.

Implementation: Beyond planning, principals must take concrete steps to transform the Education 4.0 information innovation plan into specific, actionable initiatives within their schools. This requires careful coordination across various stakeholders and a commitment to moving from theory to practice.

Classroom Leadership: Effective principals actively engage with the teaching process by immersing themselves in classroom activities. They should lead, guide, and support teachers in integrating information technology into their teaching practices, ensuring that innovative methods are being effectively utilized to enhance student learning.

Proactive Development: The essence of innovative development in educational informatization is the initiative and independent development of all stakeholders involved. Principals must not only lead by example but also encourage others—teachers, staff, and students—to take proactive roles in the continuous development of school informatization. On one hand, principals must themselves be lifelong learners, staying ahead of trends in information technology and education. On the other hand, they must cultivate a culture of proactive development within their schools, empowering others to embrace and drive innovation independently (Chow, Ren, Mathias, & Liu, 2019).

Through these behaviors, principals play a pivotal role in advancing the innovative development of Education 4.0, ensuring that schools not only keep pace with technological advancements but also lead the way in integrating those advancements into educational practices.

2.3 From Principal’s Information Leadership Behavior to Principal’s Information Leadership Framework

The principal's information leadership can be defined and structured by analyzing specific leadership behaviors associated with guiding the innovative development of information technology in education. This section outlines the framework that connects these behaviors to the broader concept of information leadership for Education 4.0.

Competency Dimensions of Principal's Information Leadership

System Transformation Promoter: This dimension focuses on the principal's ability to facilitate the transformation of school systems to align with the innovative demands of Education 4.0. Key aspects include:

Infrastructure Adaptation: Principals should lead efforts to update school infrastructure to support information technology and teaching innovation. This may involve creating maker spaces for hands-on learning or reconfiguring classroom layouts to support collaborative and inquiry-based learning.

Teaching Resource Transformation: Principals must guide the transition from traditional teaching resources to those centered around student needs. This includes developing personalized learning platforms and leveraging artificial intelligence for adaptive learning and teaching.

Application Capability Enhancement: Principals should promote the development of information technology application skills among students, teachers, technicians, and managers to ensure effective integration with teaching innovation (Liu, Huang, & Wosinski, 2017).

Institutional Innovation: Principals need to drive systemic changes such as updating teaching plans and evaluation systems to support a student-centered approach.

Cultural Atmosphere Creation: It is essential for principals to foster a culture of innovation through strategic communication, guidance, and encouragement to inspire enthusiasm for information technology among all stakeholders.

These aspects can be summarized into five core elements: infrastructure, teaching resources, team improvement, institutional innovation, and atmosphere creation (Yang et al., 2021)

Leader of Transformative Teaching: This dimension reflects the principal's role in guiding and promoting the integration of information technology with teaching innovation in the Education 4.0 context. Key behaviors include:

Experience Introduction: Principals should organize for stakeholders to learn from successful examples of integrating information technology with teaching innovation and apply these insights locally.

Exploration and Sharing: Facilitate the exploration of new methods for integrating technology and teaching innovation, and encourage the sharing of best practices among schools.

Practical Demonstration: Principals should set an example by actively exploring and demonstrating innovative practices in information technology and teaching, thereby inspiring teachers and others to engage in similar efforts.

Evaluation and Improvement: Establish mechanisms for evaluating and improving the integration of technology with teaching, continually refining practices to enhance effectiveness.

Empowerment: Encourage teachers and students to embrace exploration and address challenges or setbacks in the integration process with resilience and creativity.

These dimensions can be consolidated into five essential elements: reference introduction, organizational exploration, practical demonstration, evaluation improvement, and empowerment of teachers and students (Wang, 2019).

By defining these competency dimensions, we can construct a comprehensive framework for the principal's information leadership, which

guides the innovative development of Education 4.0. This framework helps in establishing clear roles and responsibilities for principals in leading educational transformation through effective information technology integration.

System Transformation Promoter: A Principal's Role in Advancing School Informatization to Education 4.0

The role of the principal as a System Transformation Promoter is pivotal in facilitating the transition from traditional school informatization to an Education 4.0 innovation system. This involves:

Infrastructure Modernization:

Transforming School Environments: The principal leads efforts to overhaul the school infrastructure to better accommodate the demands of Education 4.0. This includes initiatives such as establishing maker spaces to foster hands-on learning and reconfiguring classroom layouts to support collaborative and inquiry-based learning. Such transformations ensure that physical spaces align with contemporary educational practices and technologies.

Enhancing Teaching Resources:

Adopting Student-Centered Approaches: The principal is instrumental in evolving teaching resource development from a traditional model to a student-centered one. This involves creating personalized learning platforms that cater to individual student needs and utilizing artificial intelligence for tailored learning analytics. The goal is to develop resources that enhance flexible learning and adapt to students' varied aptitudes (Liu, Huang, & Wosinski, 2017).

Promoting Technological Innovation:

Advancing Technology Integration: Principals play a crucial role in fostering the innovative use of information technology across all levels of the school. This includes supporting students, teachers, technicians, and managers in acquiring and applying advanced technological skills. By providing necessary

resources and fostering a culture of innovation, principals enable effective integration of technology with teaching practices.

Institutional Innovation:

Driving Systematic Change: Principals are responsible for advocating and implementing systemic changes that support the integration of information technology with teaching innovation. This includes revising teaching plans and evaluation systems to align with student-centered learning approaches and ensuring institutional structures support ongoing technological advancements.

Cultivating an Innovation Culture:

Fostering a Supportive Environment: Principals must actively engage in creating a cultural atmosphere conducive to technological innovation. This involves stimulating enthusiasm and engagement among managers, technicians, teachers, and students through targeted publicity, guidance, and encouragement. By promoting a culture of innovation, principals help embed technology into the school's educational framework (Yang et al., 2021).

Summary of System Transformation Promoter Dimensions:

Infrastructure Modernization

Enhancing Teaching Resources

Promoting Technological Innovation

Institutional Innovation

Cultivating an Innovation Culture

These dimensions encapsulate the principal's role in guiding the transformation of school informatization to meet the demands of the Education 4.0 era, thereby positioning the school at the forefront of educational innovation.

Leader of Transformative Teaching: Principal's Role in Integrating Technology and Teaching Innovation

The Leader of Transformative Teaching refers to the principal who drives and facilitates the integration of information technology with teaching innovation in the Education 4.0 era. The principal's responsibilities include:

Facilitating Knowledge Transfer and Innovation:

Organizing Stakeholder Learning: The principal leads efforts to gather and disseminate successful practices and experiences in integrating technology with teaching. This involves organizing workshops, seminars, and training sessions to introduce and adapt proven methods to the local context, thus promoting comprehensive teaching reforms.

Fostering Collaborative Exploration:

Encouraging Teacher and Staff Engagement: The principal coordinates with subject teachers and IT support staff to explore and implement innovative methods for integrating technology into teaching. This collaboration includes sharing best practices and successful case studies with other schools to enhance collective knowledge and practice.

Demonstrating and Promoting Innovation:

Role Modeling and Advocacy: The principal leverages their role to exemplify the integration of technology in teaching, setting a standard for others to follow. By actively engaging in and promoting innovative practices, the principal inspires teachers and staff to continuously experiment and adapt new technologies in their teaching methodologies.

Implementing Evaluation and Improvement Mechanisms:

Establishing Feedback and Enhancement Processes: The principal develops and maintains systems for evaluating the effectiveness of technology-based teaching innovations. This includes creating feedback loops, assessment tools, and continuous improvement processes to refine the integration of technology and enhance teaching practices.

Empowering and Encouraging Exploration:

Supporting Risk-Taking and Resilience: The principal empowers teachers, students, and staff to embrace experimentation with new technologies and teaching methods. This involves fostering an environment where taking risks and facing potential failures are encouraged as part of the innovation process.

Summary of the Leader of Transformative Teaching Dimensions:

Reference Introduction: Facilitating access to successful practices and adapting them to the local context.

Organizational Exploration: Coordinating collaborative efforts to explore and implement innovative methods.

Practical Demonstration: Leading by example and advocating for technology integration.

Evaluation Improvement: Implementing systems for evaluating and enhancing teaching innovations.

Empowerment and Encouragement: Supporting and encouraging experimentation and resilience among teachers and students.

These dimensions highlight the principal's role in guiding and supporting the transformation of teaching practices through effective integration of technology, driving continuous improvement and fostering a culture of innovation in the Education 4.0 era., Wang, L. (2019).practical demonstration, evaluation improvement, and empowerment of teachers and students,

To further enhance the guidance and practical effectiveness of this framework, a semi-structured, open-ended questionnaire was developed, targeting primary and secondary school principals. This questionnaire elaborates on the principal’s capacity to lead the innovation and development of information technology across four dimensions and 20 basic points. Centered on the core objective of the innovative integration of information technology and teaching within the Education 4.0 framework, the principal's information

leadership is articulated through four key aspects: development planning, system transformation, teaching reform, and self-development.. Qiu, Z., & Li, J. (2017, November).

At the planning level, principals are tasked with envisioning the innovative development of school information technology through five key elements: vision planning, team formation, strategic plans, evaluation strategies, and organization and coordination. Following the completion of the educational information innovation and development plan, the focus shifts to the transformation of the school system. Principals should lead the transformation and upgrading of the school information system, addressing five critical areas: institutional atmosphere, execution team, facility resources, team improvement, and assessment implementation. This approach provides a framework for principals to guide the transformation and upgrading of the school information system.

Subsequently, the focus moves to the reform and innovation of the information-based teaching system. Principals should concentrate on five key aspects: empowering teachers and students, integrating subjects, referencing and introducing best practices, organizational exploration, and evaluation and improvement. This framework outlines a path for principals to drive the reform and innovation of the information-based teaching system.

Finally, to achieve effective reform and innovation in school informatization, principals must prioritize their professional development and embrace continuous learning. This involves five essential areas: enhancing understanding, fostering collaboration and sharing, engaging in practical reflection, embracing change, and promoting digital citizenship. This approach underscores the development of the principal's innovation and professionalism Fan, X., Wang, Y., & Lu, X. (2022).

Characteristics of the Information Leadership Framework for Primary and Secondary School Principals in Education 4.0:

Focus on Student Competencies: The framework emphasizes cultivating key qualities in students essential for thriving in an intelligent society, such as innovation, technical skills, interpersonal skills, global digital citizenship, and independent learning.Jiang, Y., Zhang, B., Zhao, Y., & Zheng, C. (2022).

Characteristics of the Information Leadership Framework for Primary and Secondary School Principals in Education 4.0:

4.2 Integration of Information Technology and Teaching Innovation:

The framework centers on integrating information technology with teaching innovation, focusing on cultivating innovative talents, empowering student-centered methods, and adapting to the intelligent era. It emphasizes personalized, inclusive, and collaborative learning, and advocates for experiential and technology-driven teaching approaches.

4.3 Empowerment Over General Management:

The framework shifts focus from traditional management functions to enhancing the principal's role as an empowerer and collaborator. It emphasizes the principal’s role in motivating and supporting stakeholders, fostering an environment of innovation, and driving the development of Education 4.0.

4.4 Changeability as a Key Competency:

Changeability is essential for the principal’s leadership in Education 4.0. The framework integrates this ability into all competency dimensions, emphasizing the need for principals to embrace uncertainties, persist through failures, and lead continuous innovation in information technology to meet the goals of Education 4.0.

summarize

In the era of Education 4.0, this article proposes a framework focusing on the innovative development of educational informatization driven by principals' leadership. The framework aims to address the challenges of educational innovation by integrating information technology and teaching. It emphasizes the principal's role in guiding this integration across four levels: the school system, teaching system, and personal development. This comprehensive framework provides standards and tools for designing training, assessments, and improving teachers' information technology skills, supporting the dynamic development of Education 4.0 and cultivating future-ready talents.

New knowledge received

The new knowledge emphasizes a comprehensive approach to the principal's role in educational innovation. Here’s a refined summary of the 4 dimensions and 20 basic points: Innovative Development Planner:Vision Planning: Develop a clear vision for integrating information technology and teaching innovation.Team Formation: Assemble and lead a team to implement the vision. Strategic Plans: Formulate detailed plans to achieve the vision. Evaluation Strategies: Set up mechanisms to assess progress and success. Organization and Coordination: Ensure effective organization and coordination of efforts. System Transformation Promoter: Institutional Atmosphere: Foster a culture conducive to system transformation. Execution Team: Build and support a team for effective system transformation. Facility Resources: Upgrade facilities to support information technology integration. Team Improvement: Enhance team skills and capabilities.Assessment Implementation: Implement assessments to evaluate system transformation. Reform Teaching Leader:Empowering Teachers and Students: Provide support and resources to enable teachers and students.Subject Integration: Integrate information

technology into various subjects.Reference and Introduction: Introduce successful practices and innovations.Organizational Exploration: Explore and implement new organizational strategies.Evaluation and Improvement: Continuously evaluate and improve teaching methods.Active Learning Demonstrator:Improving Understanding: Deepen knowledge of information technology and teaching integration.Collaboration and Sharing: Promote collaboration and sharing of best practices.Practical Reflection: Reflect on practical experiences and outcomes.Changeability: Embrace and drive change in educational practices.Digital Citizenship: Develop digital citizenship among all stakeholders.This framework underscores the principal's role in guiding educational innovation through strategic planning, system transformation, teaching reform, and active professional development.

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