

Developing Teacher Leadership in Educational Technology: A Systematic Literature Review

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Abstract: In the age of intelligence with artificial intelligence, big data, 5G, and other new technologies as the core, the development of digital technology has had a significant impact on the role and responsibilities of school leaders. Teacher technology leadership is the key factor affecting the development of school informatization. As a dynamic process, educational technology leadership is integrated by educational theory, information technology, and leadership, with an ability to promote the transformation of learning methods in the information age. With the continuous development of information technology and deepening of education and teaching reform, educational technology leadership presents a new strategic turn. In this paper, a literature review is conducted based on the concept of teacher technology leadership. Teacher leadership in technological transformation and application in the age of intelligence is analyzed, practices and models that can be learned are summarized, and methods for the improvement of teacher technology leadership are explored, so as to provide reference for academic research and teaching practice.

Keywords: Education informatization; Educational technology; Leadership.

1. Introduction

Education informatization has had a “revolutionary” impact on education and teaching. With the continuous development of teacher professionalism, “teacher technology leadership” has become an important topic in international research on teacher and education. The development of teacher technology leadership has been universally regarded as one of the effective ways to develop teacher professionalism. Since the construction of education informatization is a complex and systematic project, educational administrators are faced with two challenges, that is, how to promote the deep integration of information technology and teaching, and how to promote and guide the teaching reform with informatization. This paper believes that educational technology leadership is integrated by educational theory, information technology, and leadership, with an ability to promote the transformation of learning methods in the information age, and its development is a dynamic process. With the continuous development of information technology and deepening of education and teaching reform, the technology form, development focus, development task, development method, and development goal of education informatization have all undergone strategic shifts (as shown in Table 1). Therefore, both education informatization leadership and educational technology leadership have the characteristic of complexity, involving the responsibilities of various stakeholders in education and the whole process of school information technology development, and are affected by internal and external environmental factors. A systematic analysis of present research literature helps to explore ways to improve teacher technology leadership from multiple dimensions.

Table 1. Comparison of the development of traditional education informatization and that of future education informatization

Dimensions for comparison	Traditional education informatization	Future education informatization
Technology form	To build a digital campus based on traditional information technologies such as computers and semiconductors	To build a smart campus based on new intelligent information technologies such as big data and artificial intelligence
Development focus	Things-oriented, stressing the construction of information infrastructure	People-oriented, stressing the all-round development of teachers and students
Development task	Application-oriented, promoting the deep integration of information technology and education	Innovation-oriented, prompting education and teaching to develop from integration to innovation
Development method	Taking information technology as an exogenous variable to comprehensively promote the modernization of education	Taking information technology as an endogenous variable to support and lead the systemic reform of education
Development goal	Making education and teaching process networked and digitized, so as to reconstruct the education process	Making education and teaching process intelligent and personalized, so as to form a new ecology of education

2. The Concept of Teacher Technology Leadership

Concept interpretation is the starting point for an in-depth analysis of teacher technology leadership. The concept of teacher leadership was first proposed by Lieberman, Saxl and Miles in the book *Teacher Leadership: Ideology and Practice* in 1988. Generally speaking, the role of technology leadership in a school is played by those who are influential and willing to be leaders. "America 2000: an Education Strategy" issued by former U.S. President Bush in 1991 pointed out that students and educators must have the ability to use technology to improve student learning achievement, so as to effectively cope with the technological future. Due to the promotion of policy, technology leadership, formed by the combination of leadership and technology, has become a new trend in the research on leadership, and its relevant research is increasing. 26 states in the United States have successively set up technology leadership colleges to develop the major of technology, among which 22 states have technology leadership colleges that also provide further education for teachers and education directors, so as to help teachers and educational administrators cultivate technology leadership to effectively use technical tools in school administration.

The development of teacher informatization leadership is a dynamic process, with a connotation changing with the continuous development and advancement of information technology and education informatization. As pointed out by Bruce and other scholars, information technology and leadership interact with each other. Information technology creates a new practice environment for leadership development, thereby changing the knowledge structure of leaders and the nature of leadership. Meanwhile, leadership affects the application and effect of information technology. It is in this interaction that leader informatization leadership is mutually constructed and formed. With the continuous deepening of research on teacher technology leadership, the definition of teacher technology leadership presents research differences from various perspectives.

2.1 The Perspective of Leadership Skills

Teacher technology leadership is viewed as a leadership skill from this perspective. For example, KÖR et al pointed out that for school management, technology leadership is the leadership skill used by school leaders to promote the effective application of technology in the process of school education, and its flexible use is conducive to improving the efficacy of school management. Miller also clearly proposed that technology leadership is a combination of strategy and technology, and leaders must always pay attention to the details of technology, including understanding how technology can help teachers improve teaching efficacy, so as to promote their technology application. Ertmer indicated that technology leadership refers to encouraging and supporting teachers' use of technologies, and

promoting the skills and strategies that technology leaders should use through the establishment of vision, demonstration and guidance. In general, from the perspective of leadership skills, technology leadership focuses more on “the way and the art of applying technology to the leadership process” . Therefore, from the perspective of leadership behaviors, teachers’ application of technology leadership is the process in which new science and technology and necessary leadership skills are integrated, technical software and hardware facilities are improved, technology literacy is enhanced, a favorable environment and culture for the application of technology are shaped, and an organization is enabled to maintain strong competitiveness to achieve its goals.

2.2 The Perspective of Leadership Behaviors

Teacher technology leadership is viewed as a leadership behavior from this perspective. Scott suggested that teacher technology leadership can be regarded as a leadership behavior of teachers to demonstrate and promote the application of information technology, enabling teachers to effectively achieve the integration of technology and curriculum instruction . Brown et al. stated that teacher technology leadership can be regarded as the behavior of teachers to guide and promote school educators to learn technology, use technology, and integrate technology with curriculum instruction . Anderson held that teacher technology leadership can be considered as teachers’ decisions and actions in terms of goals, policies and budgets, so as to use information technology more effectively. In general, from the perspective of leadership behaviors, technology leadership focuses on specific details or aspects of leadership practice. Many scholars believed that technology leadership refers to the behavior that a leader combines the nature of technology and aspects of leadership to encourage school members to make good use of technology through guidance and shaping, so as to improve their administrative and teaching efficacy.

2.3 The Perspective of Integration

In this paper, according to the above perspectives, teacher technology leadership is defined as the ability of teachers to integrate their information technology literacy, ability and technological resources into leadership behaviors, which can promote teachers and students to learn and apply technology, improve teaching and administrative efficacy with information technology, and achieve organizational goals and vision. In the age of intelligence, in terms of leadership function, teachers should master the literacy of applying intelligent technology, and have the ability to integrate various resources, so as to encourage the followers to learn and make good use of information technology, improve the intelligent education literacy of teachers and students, and promote the realization of the school’s vision with intelligent technology.

3. Main Directions of Research on Teacher Leadership in Educational Technology

3.1 Core Competencies of Teacher Technology Leadership

In December 2015, the U.S. Department of Education’s Office of Educational Technology released a set of comprehensive and research-based guidelines for policies and practices implemented by future school district superintendents, namely Characteristics of Future Ready Leadership: A Research Synthesis (hereinafter referred to as “Guide”) [10]. The Guide defines four focus areas of “future-ready leadership”: collaborative leadership, personalized student learning, robust infrastructure, and personalized professional learning.

3.1.1 Collaborative Leadership

Collaborative leadership refers to the commitment of district leaders to demonstrating excellent leadership, developing the vision, securing the ongoing funding, building the district-wide leadership team for broad support, and ensuring a smooth digital learning transition for students and teachers in the district. Specific dimensions and standards are shown in Table 2.

Table 2. Dimensions and standards for collaborative leadership

Dimensions	Standards
Strong Leadership Aptitude	District leadership demonstrates situational awareness, seeks input in decision making, stimulates intellectual inquiry and innovation, and serves as a change agent for district-wide reform.
Transparent Communications	District leadership actively interacts with stakeholders to establish an ongoing communications system and feedback loop, and to gain extensive support. From the inception of the vision to its implementation, district leadership reaches a consensus.
Ongoing Plan for Improvement	A strategic plan for accomplishing the shared vision is collaboratively developed by district leadership to collect formative and summative evaluation data in real time, and to provide specific action steps and criteria for decision making.
Modeling of Technology Use	District leaders effectively model the use of technology through active participation in technology-related professional learning opportunities.
Sustainable Funding	District leadership develops funding plans to cover startup and ongoing maintenance and upgrade costs during a 5- to 10-year period. The district maximizes purchasing power of infrastructure by pooling budgets across departments.

3.1.2 Personalized Student Learning

District leadership broadens personalized pathways for student learning through the creation of active and collaborative learning activities, and assesses students' progress and preferences in real time through rich learning content and robust technology tools. Specific dimensions and standards are shown in Table 3.

Table 3. Dimensions and standards for personalized student learning

Dimensions	Standards
Rigorous Learning Outcomes	District leadership ensures a clearly defined set of learning outcomes to guide instruction. The learning outcomes reflect the multidisciplinary nature of knowledge; pay attention to students' digital literacy and citizenship; and attend to their reflective ability, critical thinking, and persistence.
Integrated Assessment	District leadership puts policies into place that ensure that the district provides educators with available and visual professional evaluation tools to collect and analyze evidence of student learning on an ongoing basis.
Pathways for Learning	District leadership carries out personalized learning activities that challenge students and reflect their interests and learning preferences to ensure that students have the opportunity to share learning outcomes and demonstrate competencies.

3.1.3 Personalized Professional Learning

District leadership supports teachers in on-going and job-embedded professional learning under the guidance of experts to help them make a smooth digital transition. Specific dimensions and standards are shown in Table 4.

Table 4. Dimensions and standards for personalized professional learning

Dimensions	Standards
Collaboration and Community	District leadership ensures a high level of collaboration between schools, districts, and teachers to support teachers in effective practices and to produce learning resources.
Shared Leadership and Ownership	District leadership participates as learners in professional learning activities, and supports teachers in modeling practices and coaching their peers through professional learning communities.
Job-Embedded and Personalized Learning	District leadership ensures ongoing professional learning in the classroom and at work. Teachers set goals, document progress, and engage in reflective practice.
Systemic Support	District leadership provides sustained support in policies to provide teachers with regular time for collaboration. Incentive and evaluation systems support professional learning and collaboration.

3.2 Research on the Support of Informatization Leadership in the Context of Online Learning

As one of the most profound changes in teaching methods in the context of information technology, online learning has always attracted the attention of foreign researchers. Informatization leadership in the context of online learning is key to promoting learning outcomes. How to build a support system for the informatization leadership of stakeholders in the whole process of online learning has attracted the attention of researchers. Both support methods and policies are core concerns of relevant research. Boelens, DeWever, and Voet (2017) pointed out four key challenges in promoting the development of student informatization leadership in the context of online learning: incorporating flexibility, stimulating interaction, facilitating students' learning processes, and fostering an affective learning climate[11].

Based on the four challenges, support methods proposed by relevant scholars are summarized as follows. First, students should be provided with sufficient choices allowing them to freely choose online or offline learning modes. And the time and content of online learning should be appropriately monitored. Second, students should be provided with face-to-face interaction with the instructor during online learning to meet their learning needs in a timely manner. Third, instructors need to formulate a learning plan based on the four links of planning, supervision, regulation and evaluation according to the characteristics of different students. Fourth, project-based group work should be adopted to regularly report, display and share learning results, so as to help students form a deep learning experience, and make up for the lack of social interaction in online learning.

In terms of support policies, Ruan Shigui and Zheng Yanlin (2015) took the United States as an example, and indicated that K-12 online learning projects have developed into various types, including single-district programs, multi-district full-time schools, consortium online programs, state virtual schools and postsecondary. With state as the main body, district as the unit, and alliance educational institutions as the supplement, a complete policy guarantee system has been formed in terms of capital investment, policy support, and quality assessment [12]. Some scholars also paid attention to the dimension of information literacy in core literacy, holding that the national standard of core literacy provides an important policy support framework for online learning.

Research by many scholars has shown that policy support is a key factor in promoting the sound development of online learning and improving the technology leadership of stakeholders in online learning. Policy support for online learning should be continuously enhanced, especially in funding teachers and other professionals. Relevant laws and regulations should be improved, and further policy research should be conducted on the monitoring and evaluation of online learning, so as to establish a complete set of policy support and monitoring systems during the entire online learning process.

3.3 Research on the Improvement of Teacher Informatization Leadership Based on Learning Analytics

The U.S. Department of Education pointed out in an issue brief, *Enhancing Teaching and Learning through Educational Data Mining and Learning Analytics*, that the application of big data in the field of education mainly includes educational data mining (EDM) and learning analytics (LA). Among them, the connotation of educational data mining refers to the quantification, analysis and modeling of students' learning behavior and process. By creating student models that incorporate such information as students' knowledge, metacognition, motivation, and attitudes, domain models that include optimal instructional sequences and the content to be learned are explored and improved, students' future development trend is predicted, and effective learning is stimulated. Learning analytics is the measurement, collection and analysis of data on students and their learning environments, with the purpose of understanding and optimizing the learning process and environment, especially organizing and constructing student characteristics through the analysis of educational big data, on the basis of which personalized resources are offered to students. It can be seen that big data technology can break the limitation that teachers only rely on subjective experience to analyze learning situation in normal teaching. In real educational scenarios, by perceiving,

aggregating and storing effective and multimodal data on students' entire learning process and learning behavior, data mining and learning analytics can realize in-depth understanding and accurate diagnosis of students' cognitive characteristics and learning rules, thus enabling teachers to provide scientific and evidence-based learning support, and further promoting accurate instruction.

3.4 Research on the Reform of Education Informatization Leadership in the Context of STEM

STEM (Science, Technology, Engineering, Mathematics) education is committed to cultivating students' ability in scientific inquiry and problem solving with the philosophy of integrating interdisciplinary knowledge. Based on the idea of broad participation and active innovation, it provides solutions to problems in current education technology leadership, such as single subject, over-reliance on tools and lack of innovation, and can effectively promote the reform of education informatization leadership. Previous research has already placed the reform of technology leadership under the philosophy of STEM education, and called for technology leadership to develop in a distributed and transformative direction, so as to enhance the efficacy of education informatization leadership. Among them, two trends in the reform of education technology leadership have received wide attention.

First, transition from leader-centered leadership to distributed leadership. Flanagan (2003) pointed out that many schools ignore the power of school community in the information construction, and their leadership style is traditional and inefficient. Education technology leadership urgently needs to move towards distributed leadership characterized by sharing and communication. In terms of knowledge creation and organization performance, relevant research has put forward the construction strategies of distributed technology leadership, such as shared vision, decentralized collaboration, and multi-party decision-making. It is believed that distributed leadership can effectively promote the knowledge creation of members in the organization when using new media technology. At the same time, the construction of a distributed leadership structure can improve organization performance.

Second, transition from transactional leadership to transformational leadership. Fang Hui, He Bin, and Zhang Qian (2017) stated that transactional leadership generally refers to a leadership style that uses rewards and punishments to influence the behavior of members in the organization, adversely affecting school reconstruction in the information age. Therefore, many scholars have proposed that education informatization leadership should shift from transactional leadership to transformational leadership in order to promote information construction in schools. Transformational leaders can encourage their followers to devise creative solutions to complex problems, stimulate their best efforts to achieve information technology integration, help teachers learn to generate an innovative culture, and ultimately form a vision of technology integration that enhances technology integration.

4. Conclusion

In conclusion, the development of digital technology has had a significant impact on the reform of teacher leadership. Since school reform is a complex and systematic project, in the process of professional development, principals, administrators, and teachers should think about obstacles, goals and paths faced by the integration of educational theory, information technology, and leadership, and continuously explore and reflect on how to apply information technology to the leadership process. The improvement of the structure of education informatization leadership requires the wisdom and strength of all school members, especially teacher leadership, so as to achieve the modernization of education.

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