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Teacher technology usage, a catalyst for principal digital leadership practice

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ABSTRACT

In the digital age, university principals and teachers share the same responsibility for improving educational digital transformation. However, their performance remains disadvantaged. This study aims to investigate the relationship between principal digital leadership and teacher technology usage, and explores how teacher technology usage contributes to principal digital leadership. The study employed a quantitative method, collecting data from 500 teachers across 25 universities in Jilin Province, China. Pearson correlation analysis examined the association between principal digital leadership and teacher technology usage, while multiple regression explored how teacher technology usage contributes to principal digital leadership practices. The results revealed a positive relationship between principal digital leadership and teacher technology usage. All four dimensions of teacher technology usage contribute to digital leadership practices, with the professional development dimension showing the greatest impact. Overall, these findings prove that teacher technology usage indeed catalyzes principal digital leadership practices, which contributes to understanding of the interaction in leadership and provides a new perspective for enhancing principal digital leadership. It implies that principals and teachers can grow together in their interactions. Therefore, strengthening teachers' professional development can contribute to principal digital leadership practice.

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1. INTRODUCTION

The updated digital technologies are posing new challenges for principals and teachers in universities to face. In this context, the rapid advancement of digital technologies necessitates a collaborative effort from both principals and teachers to enhance the digital transformation of education. Traditional principal leadership can no longer meet the needs of principals to lead universities to develop smoothly in digital age. Digital leadership has become an inevitable trend [1]. Despite this need, both principals and teachers have not fully recognized their roles in this transformation, and their performance in adapting to these changes remains negative. Meanwhile, teachers, as followers are an important component of leadership in universities, without the effort of teachers, universities cannot provide teaching and learning services to students [2]. Up to now, most of the empirical studies have focused on the role of digital leadership in teachers' behavior [3]. However, there is still a lack of research that discusses the interaction between leaders and followers from teachers' perspectives.

In the digital age, teacher technology usage is becoming increasingly common and diverse in higher education. Effective teacher technology usage not only facilitates communication, changes teaching style, but

also better meets the needs of students [4]. In addition, teachers' advances in technology can drive continuous innovation and self-improvement in their professional development [5]. Meanwhile, teachers use technology to influence students to use it in the same way, which provides students with global competitiveness in the ever-changing job market [6]. In this context, "technology" refers to digital tools, platforms and digital resources used by teachers for various purposes, including professional development, teaching, communication, and management [7]. Existing research highlights the beneficial roles of teacher technology usage. It improves teaching quality and enhances students' academic achievement. Additionally, technology usage can also increase productivity, making course management, student assessment, and daily communication more efficient [8]. Despite these benefits, there is a notable gap in the research concerning the impact of teacher technology usage on leadership dynamics, specifically how teachers as followers influence principal leadership.

Leadership is essential for a university to create lasting digital transformation and a greater level of effectiveness [9]. Unlike other leadership types, digital leadership is functionally-oriented leadership developed from transformational leadership, including core competence that enables universities to adapt to and adopt emerging technologies to improve instructional and administrative effectiveness [10]. Understanding the definition of digital leadership is fundamental to delving into the field of digital leadership. A comprehensive definition of digital leadership should include the elements of competence, followers, motivation, goals, and interactive processes [11]. Therefore, in this study, digital leadership is not only about the leader's ability to master technology but also about how the leader interacts with followers and motivates them to use technology to achieve common goals. The continuous interaction between leaders and followers should not be overlooked. To maximize the effectiveness of leadership, previous leadership research has focused primarily on the role of digital leadership, such as the role in influencing teacher digital competence, teacher technology integration, and university digital culture, the use of technology by teachers, and the digital culture of the school, while ignoring the factors that influence leadership [12].

Numerous previous studies confirm a positive correlation between principal digital leadership and teacher technology usage. AlAjmi [13] revealed that principal digital leadership is a significant predictor of teacher technology integration. Principals encourage teachers to use technology by providing digital infrastructure to ensure teachers have access to digital devices [14]. Also, by setting goals and clear visionary plans [15]. However, previous leadership practice tended to be top-down, from principals to teachers. This form ignores interaction. While the principal digital leadership has a significant impact on teacher technology integration, the relationship should be viewed more as an interactive process of two-way facilitation and mutual growth. Moreover, according to the concept of leadership, leadership is an interaction between leaders and followers [10]. Furthermore, compared to principals in universities, teachers as digital natives often outpace principals in their use of technology, teachers can use technology in more innovative ways [16]. Teachers' actual technology usage and feedback in turn influence principal decision-making and alignment of digital leadership strategies. Therefore, to accelerate the digital transformation of education and enhance digital leadership, it is important to delve deeper into teacher technology usage and how teacher technology usage impacts digital leadership practices and decisions.

To address these gaps, this study proposes a perspective that emphasizes the interaction between principals and teachers in the context of digital leadership. This study aimed to examine the relationship between teacher technology usage and principal digital leadership, and further revealed how technology usage contributes to principal digital leadership practice. This approach not only expands the understanding of digital leadership interactive process but also provides actionable insights for improving leadership practices through active engagement with teachers. By doing so, the research addresses a critical gap in the literature and offers practical solutions for enhancing the effectiveness of digital leadership in higher education. To address these issues comprehensively, this study was conducted in Jilin Province, China, a region undergoing rapid educational reforms and digital transformation. The research focuses on 25 universities across the province, encompassing a diverse range of institutional contexts and educational practices. Thus, the research questions (RQ) of the study are:

i) RQ1: is there a positive relationship between teacher technology usage and principal digital leadership?
ii) RQ2: does all the dimensions of teacher technology usage contributes to principal digital leadership?

In subsequent sections, the paper will provide a detailed methodology. It contains research design, population and sampling, instrument and data analysis procedure. Followed by the data analysis, and its discussion with the existing literature. The concluding section will reflect on the implications for educational leadership and make recommendations for promoting the development of digital competencies among teachers and principals.

2. METHOD

2.1. Research design

This study used a quantitative research approach employing a correlational research design to examine the relationship and impact of teacher technology usage on principal digital leadership. Data were collected cross-sectionally from university teachers in Jilin Province, China. Relevant variables were measured and analyzed using questionnaires to explore correlations between them.

2.2. Population and sampling

The population of this study is the whole population of teachers from a total of 25 universities in Jilin Province. The number of populations is 25,912. To make the results representative, the sampling in this study is strictly random sampling. The sample size was calculated by Morgan and when the population is greater than 20,000, the sample size should be 377. Considering the recovery rate of the sample, the sample size of this study was added to 500. The 466 valid questionnaires were recovered in this study, which has a recovery rate of 93.2%.

As shown in Table 1, of the participants, 56.9% were female, slightly more than male. The largest number of these teachers, 44.4%, were in the 31-40 age group. Among the teachers, the number of science teachers was balanced with the number of arts teachers, with 51.7% in science. The share of arts subjects is 48.3%. Of these teachers, 38% indicated they had six to ten years of experience in using computer, followed by 32.2%,19.1%, and 8.2% of teachers with experience in using computer in the range of below 5, 11 to 15 years and 16 to 20 years respectively. Only 2.6% of teachers had more than 20 years of experience in using computer.

Table 1. Respondent demography

Demographic	Category	Frequency	Percentage (%)
Gender	Male	201	43.1
	Female	265	56.9
Age	20-30	86	18.5
	31-40	207	44.4
	41-50	147	31.5
	Above 50	26	5.6
Academic discipline	Social sciences and humanities	225	48.3
	Natural sciences and technology	241	51.7
Experience in using computer	Below 5	89	19.1
	6-10	177	38
	11-15	150	32.2
	16-20	38	8.2
	Above 20	12	2.6

2.3. Instruments

There are two instruments for this current study, namely principal digital leadership and teacher technology usage. A 5-point Likert scale was adopted, which ranges from 1 (strongly disagree) to 5 (strongly agree). The instruments were filled by teachers. The instrument of principal digital leadership was revised from international society for technology in education-administrators (ISTE-A) (2018) with 23 items. The reliability and validity of the principal digital leadership have been tested in studies in the contexts of Mainland China and Malaysia [17]. The instrument of teacher technology usage was adopted from the types of teachers' activities with technology designed by the Chilean Ministry of Education which has 18 items from four dimensions, they are professional development, communication, teaching, and administration. Since this study was conducted in Mainland China and the original instruments were in English, the researcher employed the back-translation method to ensure clarity and understanding for participants.

2.4. Data analysis procedure

The data collection process was conducted through an online survey to enhance efficiency and reach. The research team distributed the survey link via email to randomly selected teachers. Ultimately, a total of valid questionnaires (n=466) was collected, ensuring that the sample size met the needs of the statistical analysis. Data analysis was conducted using SPSS software, which provided tools for both descriptive and inferential statistical techniques. Pearson correlation analysis was employed to examine the strength and direction of the relationship between principal digital leadership and teacher technology usage. Multiple linear regression was then used to explore the relative contributions of different dimensions of teacher technology usage to principal digital leadership, identifying which dimension had the greatest impact. Before conducting the regression analysis, the data underwent pre-processing in SPSS, including testing for residual normality and homoscedasticity to ensure that the data met the necessary assumptions for multiple linear regression.

3. RESULTS AND DISCUSSION

3.1. The relationship between teacher technology usage and principal digital leadership

The study used the Pearson correlation to test the relationship between teacher technology usage and principal digital leadership. As shown in Table 2, the Pearson correlation was calculated r=0.604, p<0.00. A statistically significant association was discovered. This statistically significant association indicated that higher levels of teacher technology usage are associated with more effective principal digital leadership.

Regarding the relationship between principal digital leadership and teacher technology usage, these findings are consistent with earlier studies. For example, AlAjmi [13] confirmed a positive relationship between principal digital leadership and teacher technology usage. Similarly, a study conducted in the Chinese context, found that principal digital leadership improve the teachers' motivation and attitude to integrate technology into teaching process [8]. These studies highlight the role of principals in fostering an environment that encourages and supports the use of technology in education, which already set the direction for the relationship. However, in contrast to these findings, Ismail *et al*. [18] reported no significant effect between principal digital leadership and teacher technology usage, raising questions about the consistency of this relationship across different settings.

These discrepancies may arise from the varying contexts of the studies [19]. On the one hand, educational settings differ significantly in terms of technological infrastructure, access to resources, and the level of support provided to teachers, all of which can influence the effectiveness of digital leadership [20]. On the other hand, the specific scales used to measure digital leadership and technology usage may vary between studies, leading to discrepancies in research findings by Sujaya [21]. Additionally, the cultural context cannot be overlooked. In some cultures, hierarchical structures might mean that teachers are less empowered to influence or respond to leadership initiatives, thereby diminishing the observable effect of principal digital leadership on their technology usage [22]. These contextual and methodological differences highlight the importance of considering local factors when evaluating the impact of digital leadership on technology usage in educational settings.

Table 2. The Pearson statistic between teacher technology usage and principal digital leadership

Variable		Teacher technology usage
Principal digital leadership	Pearson correlation	0.604**
	Sig. (2-tailed)	<0.001
	N	466

3.2. The dimensions of teacher technology usage contribute to principal digital leadership

Pearson correlation coefficient reveals a significant linear relationship between teacher technology usage and principal digital leadership. The skewness of principal digital leadership is 0.42, meeting the criterion of being less than 1.96 [23], which indicates that the normality assumption is satisfied. Additionally, as shown in Table 3, the Durbin-Watson value is 1.808, close to 2, suggesting no significant autocorrelation of the residuals, thus ensuring their independence [24]. As displayed in Figure 1, the scatter plot of residuals against predicted values shows that the residuals are uniformly distributed across different predicted values, confirming the assumption of homoscedasticity [25]. These fulfilled conditions enhance the explanatory power and predictive performance of the multiple linear regression model.

After satisfying all assumptions, further analysis through multiple regression was carried out to uncover the four dimensions of teacher technology usage (professional development, communication, teaching, and administration) that forecast principal digital leadership. As shown in Table 3, the R^2 indicates that nearly 37.3% of the variance in teacher technology usage can be predicted from principal digital leadership practice, which is a large effect. Meanwhile, as shown in Table 4, F=68.419, p<0.05 indicated that the effect on principal digital leadership practice was statistically significant.

Further analysis found that all four dimensions (professional development, communication, teaching, and administration) affect principal digital leadership. As presented in Table 5, professional development contributed the most, followed by administration and communication. Teaching was the dimension that contributed the least, but it still positively influenced principal digital leadership.

Table 3. Multiple regression on teacher technology integration to principal digital leadership

R	R^2	Adjusted R^2	Standard error	Durbin-Watson
0.610	0.373	0.367	0.444	1.808

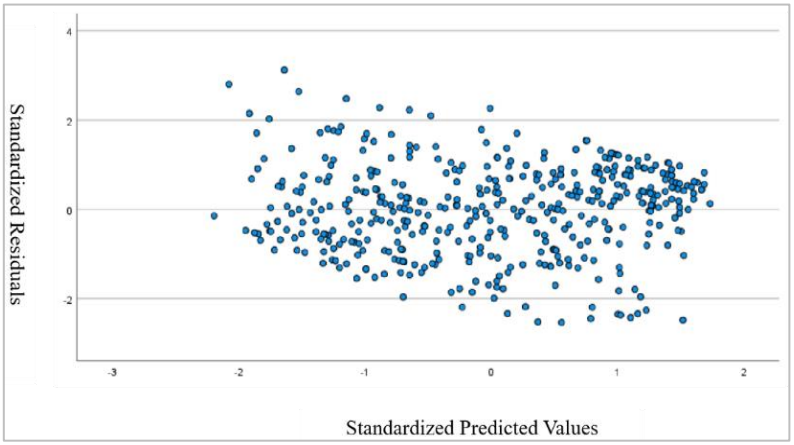

Figure 1. Plots of predicted values of dependent variable against regression standardized residuals

Table 4. Multiple regression analysis: ANOVA

	Sum of squares	df	Mean square	F	Sig.
Regression	54.049	4	13.512	68.419	0.000
Residual	91.043	461	0.197		
Total	142.092	465			

Table 5. Regression coefficients, observed T-statistics, and p-value for contribution of teacher technology usage to principal digital leadership

Variables	β	SE B	t	p
Professional development	0.202	0.226	4.066	<0.001
Communication	0.119	0.130	2.362	0.019
Teaching	0.109	0.121	2.243	0.025
Administration	0.206	0.226	3.854	<0.001

Previous studies have largely focused on the impact of principal digital leadership on teacher behavior, often overlooking the reverse relationship—how teachers, as followers, influence the digital leadership practices of principals [26]. This study addresses this gap by examining the dimensions of teacher technology usage that contribute to principal digital leadership. Among these dimensions, professional development emerged as the most influential dimension. This can be explained by the fact that when teachers actively engage in professional development related to technology, they not only enhance their own competencies but also create a more supportive and technical environment that allows principals to implement more advanced and strategic digital initiatives, so that to display their digital leadership [27]. This creates a virtuous cycle, where teachers' advancements in technology usage encourage more effective leadership, which in turn fosters further technological integration.

Administration was the second most impactful dimension, with teacher's integration of technology improving both subject matter management and day-to-day administrative tasks, thereby supporting principals in their digital management efforts. This aligns with earlier study by Rodriguez [28], which found that when teachers are proficient in administrative technology, it reduces the burden on school leadership, allowing principals to focus on strategic initiatives rather than getting bogged down in operational details. This support in administrative efficiency not only eases the workload on principals but also enhances their ability to focus on broader digital leadership strategies.

Surprisingly, teaching is the dimension that has the least impact on principal digital leadership. This maybe because the effects of teachers' use of technology in teaching process often take months or even longer to manifest in student learning outcomes [29]. Consequently, principals may find it challenging to obtain rapid feedback on the effectiveness of instructional technology, thereby limiting the immediate influence of this feedback on their digital leadership [30]. Additionally, the integration of technology in teaching process relies heavily on teacher autonomy [31]. How teachers incorporate technology into their classrooms often depends on their individual teaching styles and curricular needs [32]. While personalized use of instructional technology is crucial for each teacher, it is difficult to uniformly reflect this individualized approach in the alignment with the principal digital leadership practice.

3.3. Implication

The results contribute to a clearer understanding of digital leadership by shifting the focus from the effect of principal digital leadership on teacher behavior to a more interactive process of leadership. The results provide significant insights into the interactive nature of digital leadership, shift the focus from a traditional top-down leadership model to a more dynamic process. These insights have several important theoretical and practical implications.

On the one hand, the study highlights the need to move beyond traditional, principal-centered models of digital leadership to more interactive frameworks. Future research should focus on developing and refining leadership models that consider the mutual influence between teachers and principals. By acknowledging this two-way interaction, these models would provide a clearer understanding of how leadership in university develops, particularly in relation to how teacher behaviors and the use of technology shape digital leadership over time.

On the other hand, the strong contribution of professional development to digital leadership highlights the importance of structured and continuous professional development opportunities. Based on the findings, universities should design training programs that not only enhance individual teacher competencies but also cultivate a collaborative environment that requires the active participation of principals. Such training can strengthen leadership interactions and improve the effectiveness of leadership. Similarly, it is crucial to create a campus environment that involves both teachers and principals. For instance, implementing regular feedback loops and joint decision-making processes can provide principals with valuable feedback on their leadership behaviors, thereby enhancing their leadership effectiveness.

Overall, university management should establish more effective communication channels to ensure that teachers' experiences and feedback on technology usage are effectively communicated to principals. This will help principals make more informed decisions that support and promote technology integration. Additionally, principals should increase their focus on professional development for teachers by providing ongoing training and development opportunities to enhance their technology use.

However, this study has several limitations. The sample was primarily drawn from universities in specific geographical and cultural contexts, which may limit the generalization of the findings. Practices and challenges in digital leadership and technology integration can vary significantly across different regions and cultures [18]. Additionally, the study relied on self-reported data from teachers, which maybe subject to subjective bias. Teachers and principals may overestimate or underestimate their technology use and leadership skills due to social desirability effects or self-assessment biases. Furthermore, the cross-sectional design of the study only captures the phenomenon at a specific point in time, failing to reveal the dynamic process of how teacher behavior impacts principals' digital leadership over time. Future studies should include comparisons across different geographical and cultural contexts to enhance the generalization of the findings. Combining observational methods or third-party assessment data with self-reported data could also improve the objectivity and reliability of the results.

4. CONCLUSION

This study highlights the impact of teacher behavior on principal digital leadership practices. The research questions focused on analyzing the interactive process of this influence, with particular attention to the contributions of four dimensions: professional development, communication, teaching, and administration, to principal digital leadership. Using a quantitative research approach with Pearson correlation and multiple linear regression analysis, the results revealed a positive correlation between teacher technology usage and principal digital leadership practices. Each of the four dimensions was found to significantly contribute to the enhancement of principal digital leadership, with professional development emerging as the most influential factor. In sum, this research highlights the importance of a collaborative approach to digital leadership, wherein both teachers and principals play active roles in shaping the future of education. By recognizing and leveraging the influence of teacher behavior, universities can foster a more effective and sustainable digital leadership environment. These findings stress the necessity of joint participation and cooperation between teachers and principals in implementing digital leadership, thereby contributing to the long-term development and improvement of educational practices.

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