

Article

Reversing the Influence: How Teacher Technology Adoption Shapes Principal Digital Leadership Practice?

Rui Zhu¹, Bity Salwana Alias², Mohd Izham Mohd Hamzah³

1. Faculty of Education, Universiti Kebangsaan Malaysia, Selangor, Malaysia; Email: 920429393@qq.com

2. Faculty of Education, Universiti Kebangsaan Malaysia, Selangor, Malaysia; Email: bity@ukm.edu.my

3. Faculty of Education, Universiti Kebangsaan Malaysia, Selangor, Malaysia; Email: izham@ukm.edu.my

* Corresponding Author : Rui Zhu

Abstract. In the field of leadership, traditional literature has largely focused on how followers are influenced by leaders or how they act as mediators between leadership and behaviors. However, leadership is a process of interaction, leadership research should shift this focus to emphasize the influence of followers on leaders. Therefore, this research examines how teacher technology adoption impacts principal digital leadership practices. A quantitative survey method was employed, collecting data from 382 university teachers in Changchun city, China, with Pearson correlation and multiple regression data analysis. The results revealed that there is a positive relationship between teacher technology adoption and principal digital leadership, as well as confirmed a statistically regression model from teacher technology adoption to principal digital leadership practice. The further analysis showed that communication dimension contributes most, while teaching dimension has a very weak effect on principal digital leadership practice. The study provides valuable contributions to both theory and practice, discusses the findings and implications in detail. The significance of the study derives from its ability to deepen our understanding of the reciprocal influence between digital leadership and technology adoption in higher education, offering insights for future research and practical applications in similar contexts.

Keywords: Teacher Technology Adoption; Principal Digital Leadership; survey; regression analysis; China.

1. Introduction

University principals as the first moves of digital education, are traditionally treated as heroes depending on how well their universities perform in digital age (Antonopoulou, Halkiopoulou, Barlou, & Beligiannis, 2021). In this context, extensive research has explored the influence of university principals digital leadership on teachers' behavior, such as teacher digital competence, technology usage, commitment, or performance (Hamzah, 2021; Karakose, Polat, & Papadakis, 2021; Laufer et al., 2021). However, leadership is a process of interaction between leaders and followers, the impact of followers on leaders has been largely ignored (Gesang & Süß, 2021). To address this existing gap in knowledge, we shift the prevailing perspective and take a look at how followers' behavior affects leaders.

In digital age, traditional leadership is no longer sufficient to meet the evolving demands placed on university principals. Digital leadership has emerged as a critical form of leadership in this context (Antonopoulou et al., 2021). It refers to the incorporation of digital technologies into the leadership practices of principals to direct, influence others, and initiate sustainable change for future university success (Rui, Alias, Hamzah, & Wahab, 2024). When discussing digital leadership, a majority of the literature have indeed validated the crucial role of leadership on followers, the enhancement of organizational environments, and the promotion of organizational development (Shin, Mollah, & Choi, 2023). However, these studies often overlook the interactive process between leaders and followers, particularly how followers, such as teachers, can shape the university principal digital leadership practices. This gap highlights the need for a deep understanding of digital leadership that considers the interactive nature of leadership.

Received: 19 April, 2025

Revised: 16 May, 2025

Accepted: 15 June, 2025

Online Available : 18 June, 2025

Curr. Ver.: 18 June, 2025



Copyright: © 2025 by the authors.

Submitted for possible open

access publication under the

terms and conditions of the

Creative Commons Attribution

(CC BY SA) license

(<https://creativecommons.org/licenses/by-sa/4.0/>)

In fact, the educational digital transformation not only relies on the university principals, but also necessitates the collective involvement of all stakeholders (Xiao, 2019). As the core organizers of teaching practices, teachers play a significant role in shaping the pace of a university's digitization process through their attitudes towards technology adoption (Zhao, 2022). Teacher technology adoption encompasses various aspects, including the integration of teaching tools, utilization of digital resources, management of online platforms, and the development of students' digital literacy (Rui et al., 2024). Existing research indicates that teachers' active role in technology adoption not only enhances students' learning experiences and academic achievements but also fosters innovation in teaching methods and improves teaching efficiency (Alexandro & Basrowi, 2024). However, teachers' influence extends beyond the student and instructional levels. Teachers play an indispensable role in the leadership structure.

Effective leadership encompasses the dynamic interactions between leaders, followers, and situations (Sumardi & Efendy, 2017). Leadership is not solely dependent on the traits and behaviors of leaders; it is an interactive process that requires the active participation and feedback of followers (Sumardi & Efendy, 2017). Interaction can yield outcomes that enhance performance quality, making it a crucial element of organizational success (Crevani, Lindgren, & Packendorff, 2010). Consequently, university principal digital leadership are inherently tied to their interactions with teachers. Without followers, leadership and organizations lose their meaning and purpose. However, existing research often overlooks the critical role of followers in leadership process (Rui et al., 2024). In reality, a good follower can also significantly influence the leader. Teachers' feedback and behaviors can profoundly foster more effective digital leadership practices (Velez & Neves, 2022). Therefore, attention should be directed towards teachers' technology behaviors, examining how teachers, influence the digital leadership.

To gain a deeper understanding of the interactive process of leadership, this study was conducted in the Changchun City, China. As a major educational hub in Northeast China, Changchun is home to 17 universities, encompassing all types of higher education institutions in China, including comprehensive universities, science and engineering institutions, and normal universities. This diversity of university types provides a comprehensive research sample, reflecting the diversity and universality of digital leadership practices across different educational contexts. Therefore, conducting research in Changchun is not only representative but also offers valuable insights that can serve as a reference for other regions and institutions. The specific research objectives include:

RO1: To assess the impact of teachers' technology usage on the digital leadership practices of university principals;

RO2: To identify the contribution of various dimensions of teachers' technology usage to these digital leadership practices.

Through quantitative analysis, this study aims to uncover the specific role that teachers play in enhancing the digital leadership of university principals, providing theoretical support and practical guidance to further advance the overall digital transformation of higher education. The remainder of this paper is organized into five sections: theoretical foundation, research methods, results, discussion, and conclusion.

2. Literature Review

The definitions of digital leadership

In digital age, digital leadership is an emerging trend for equipping principals to face the challenges. A clear understanding of digital leadership is a direct for the school development. Therefore, an increasing number of scholars began to explain and explore the definition of digital leadership. These definitions of digital leadership are proposed based on different perspectives (Zhu, Alias, Hamzah, & Ab Hamid, 2024). In an earlier time, the definition of digital leadership is defined as leader's ability to make decision, such as policy, development vision and supports for integrating technology into teaching and learning process (Gronow,

2007). This definition highlighted that leaders make followers to use technology. However, this definition neglected self-development of leaders, and ignore the management process. To address this limitation, Liu, Wang, and Liang (2019) confirmed digital leadership as a new training for improving professionalization both for principals themselves and teachers with digital tools. Similarly, Viewed through the lens of traditional leadership, this definition is incomplete as overlooked fundamental elements like followers, shared goals, and the interaction process between leaders and followers (Antonopoulou et al., 2021). In response, Zhu et al. (2024) proposed a more comprehensive definition, which encompasses not only the leader's ability to master and utilize technology but also the process by which leaders interact with their followers, motivating them to use digital tools to achieve shared objectives.

The role of leaders in digital leadership research

In recent years, scholars have actively explored the roles and impact of digital leadership in educational management. Traditionally, the focus has been on how these followers are influenced by the leadership, particularly how the principal digital leadership impacts the behavior and practices of teachers and students (Yusof, Yaakob, & Ibrahim, 2019), such as outcomes of students, teachers' behavior and the whole development of educational institutions. For example, Berkovich and Hassan (2023) found that effective digital leadership can significantly improve teachers' motivation and in turn enhance students' learning. Through the teachers' perspective, principal digital leadership contribute to teacher digital competence (Yuting, Adams, & Lee, 2022), teacher technology integration (Zhou & Tse, 2023), job satisfaction (Tanucan, Negrado, & Malaga, 2022) and well-being (Zeike, Bradbury, Lindert, & Pfaff, 2019). Meanwhile, principal digital leadership significantly impact the school effectiveness, making further school success (Berkovich & Hassan, 2023). Therefore, the impact of principal digital leadership is evident across various aspects of school development. Nonetheless, existing research has predominantly focused on the top-down influence of leaders, often overlooking the processes that occur from followers to leaders (Tanucan et al., 2022). In the context of rapidly advancing educational technology, leaders must be agile and responsive to constant changes (Wang & Chu, 2023). This adaptability requires leaders to adjust their strategies and goals based on feedback from their followers, thereby enhancing the effectiveness of digital leadership in school settings. Consequently, research on digital leadership should expand its scope to include the decisions, behaviors, and attitudes of followers, emphasizing the dynamic interplay between leaders and those they lead (Wroblewski, Scholl, Ditrich, Pummerer, & Sassenberg, 2022).

Follower-centered approaches to leadership

Traditionally, a majority of research focus on leader-centered approaches to leadership. A substantial body of research has established a significant relationship between principal digital leadership and teacher technology adoption, with various dimensions of digital leadership contributing positively to teacher technology adoption (Zhu et al., 2024). By setting clear goals and visionary plans, principals encourage teachers to embrace and effectively utilize technology in their instructional practices (Magagula & Chikoko, 2025). The effectiveness of leadership is increasingly recognized as being contingent upon the performance, behavior, and attitudes of followers (Oktavia & Abimanto, 2024). Therefore, even though the influence of principals on teachers' technology integration is well-documented, this relationship should be understood as a reciprocal, interactive process that fosters mutual growth. Teachers are not merely passive recipients of leadership; their actual use of technology, along with the feedback they provide, can significantly influence principals' decisions and the adjustment of digital leadership strategies. In other words, whether a leader's digital strategy succeeds or fails often depends on how teachers, as key followers, respond to and engage with the initiatives set forth by the principal.

As proposed by implicit leadership theories, leadership primarily exists in the minds of followers, marking a significant shift from a leader-centered to a follower-centered perspective (Velez & Neves, 2022). Wang and Chu (2023) argued that leadership is effective only when followers perceive it as such that approved that leadership effectiveness is co-constructed through ongoing interactions. Leaders influence the behavior of followers, while the perceptions of followers, in turn, drive the behavior of leaders. Despite this, the majority

of the literature still portrays followers as non-actors, focusing primarily on the leader's influence and overlooking the agency of followers in shaping the leadership process (Karakose et al., 2023). To fully understand digital leadership in educational settings, it is essential to broaden the research lens to include followers not just as subjects of leadership but as active participants who co-create the leadership experience. This shift in perspective acknowledges that digital leadership is not a one-way street but a collaborative process where both leaders and followers play integral roles in driving technological integration and innovation within schools.

3. Methods

Research design

This study employs a quantitative research methodology, specifically a survey study, to examine the relationship between teacher technology adoption and principal digital leadership in universities in Changchun City, China. This study also explores the effect of teachers' behavior on university principal digital leadership practice. Based on these research objectives and research design, this current study adopted cross-sectional online questionnaires to gather data from a diverse sample of teachers across multiple universities, to ensure the sample can cover the characteristics of population. This research design ensure a comprehensive and representative of the correlation between these two variables in the context of universities of Changchun City.

Population and sampling

There are 17 universities in total in Changchun, China, with 17650 teachers. To ensure the representativeness of the findings, a two-stage sampling was employed. In specific, the first stage is stratified sampling that divided the population into 17 strata based on the universities, meanwhile, the second stage is simple random sampling that the teachers were randomly selected from each university according to their proportion in the overall population. This approach ensured that teachers from larger universities had the same probability of being included as those from smaller universities. Since teachers' information is private in universities and not public available. This process involved assigning a unique identification number to each teacher in the stratum and then using a random number generator to select teachers. And then used Random.org Website to calculate random numbers. Such a combination of stratified and simple random sampling techniques strengthened the representativeness and generalizability of the sample.

According to Morgan's Table, when the population exceeds 15,000, a sample size of 377 is recommended. Taking into account potential issues with sample recovery rates, the sample size was increased to 450. Ultimately, 382 valid questionnaires were collected, achieving a response rate of 84.8%, which meets the required standard for sample recovery.

Instruments

This study utilized two primary instruments: Principal Digital Leadership (PDL) and Teacher Technology Adoption (TTA). Both instruments employed a 5-point Likert scale, with responses ranging from 1 (strongly disagree) to 5 (strongly agree). The instruments filled by teachers. There are 23 items in PDL instrument, which adapted from ISTE-A (2018) standards. It has been previously employed in research conducted within the context of Chinese universities, ensuring consistency and reliability in the measurement tools. The TTA instrument is adopted from an educational program in China, includes 18 items, which presents four activities with technology. These activities are professional development (PD), communication (COM), teaching (TEH), and administration (AD). Since one of the two instruments was in English, a back-translation method was employed to ensure that the translated questionnaires were accurately understood by participants.

Data collection and analysis

The data collection process was carried out through an online survey. Meanwhile, the research proceed random sampling with Random.org.website. Initially, the study employed stratified sampling, categorizing the universities into 17 strata. The Probability Proportional to Size (PPS) method was applied to determine the number of participants sampled from each university, ensuring that larger institutions were proportionally represented with more teachers in the sample. This approach was designed to capture the diversity of the overall population accurately. After that, random numbers generated by the Random.org website were used to match the corresponding teachers within each university. To facilitate data collection, a dedicated online communication group was established for each university, and the survey link was distributed to participants through these groups. Ultimately, a total of 382 valid responses were collected, ensuring that the sample size met the requirements for statistical analysis.

Data analysis was performed by SPSS software, offering a comprehensive suite of tools for conducting both descriptive and inferential statistical analyses. The strength and direction of the relationship between principal digital leadership and teacher technology adoption was assessed through Pearson correlation analysis. And then use Multiple Linear Regression to examine which dimension of teacher technology adoption contributes to principal digital leadership practice. Therefore, after data screening and cleaning, several assumptions were tested to ensure the data meet the requirement of multiple regression, including linearity of the relationship between the dependent and independent variables, no autocorrelation, absence of multicollinearity among independent variables, normality of residuals, and homoscedasticity.

4. Results

The Relationship between teacher technology integration and principal digital leadership Through Pearson correlation analysis, this study explores the relationship between teacher technology adoption and principal digital leadership. As shown in Table 1, the Pearson correlation coefficient is $r=0.700$, with a p-value less than 0.00, indicating a significant statistical relationship. This suggests that when teachers are more proactive and skilled in integrating technology into their teaching, it can influence principals' capacity to implement effective digital leadership practices.

Table 1 The Pearson statistic between teacher technology adoption and principal digital leadership

Variable		Teacher technology adoption
Principal digital leadership	Pearson Correlation	0.700**
	Sig. (2-tailed)	<0.001
	N	382

The dimensions of teacher technology integration contribute to principal digital leadership

Based on the results of the Pearson correlation coefficient, a significant linear relationship was found between teacher technology adoption and principal digital leadership. Additionally, the skewness of principal digital leadership was -0.049, which is below the critical value of 1.96, indicating that this variable meets the assumption of normal distribution. Furthermore, the Durbin-Watson statistic in Table 2 is 1.629, which is close to 2, suggesting that there is no significant autocorrelation in the residuals, ensuring their independence. The scatter plot of residuals versus predicted values shows that the residuals are evenly distributed across different levels of predicted values, supporting the assumption of homoscedasticity, which was displayed in Figure 1. The fulfillment of these statistical conditions enhances the explanatory power and predictive performance of the multiple linear regression model.

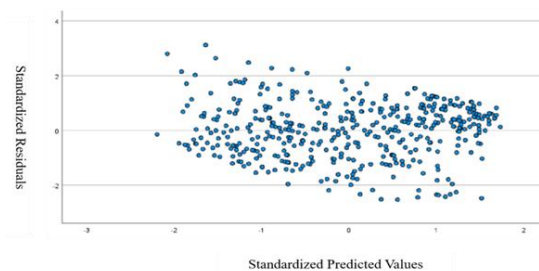


Figure 1. Plots of predicted values of DV against regression standardized residuals

After meeting all the assumption conditions, this study employed multiple regression analysis to explore the predictive effects of four dimensions of teacher technology adoption (professional development, communication, teaching, and administration) on principal digital leadership. According to the results in Table 2, the coefficient of determination R^2 indicates that approximately 51.1% of the variance in teacher technology use can be explained by principal digital leadership practices. This suggests that principal digital leadership practices have a statistically significant impact on teacher technology use.

Table 2 Multiple Regression on teacher technology adoption to principal digital leadership

R	R^2	Adjusted R^2	Standard Error	Durbin-Watson
0.715	0.511	0.506	0.449	1.629

As seen in Table 3, $F=98.574$, $p<0.05$, which means the regression model is statistically significant. Meanwhile, according to Cohen's (1988) standards, this effect size falls within the large range, demonstrating a strong association between the variables. This suggests that the independent variables included in the model have a substantial explanatory power in predicting the dependent variable.

Table 3 Multiple Regression Analysis : ANOVA

	Sum of Squares	df	Mean square	F	Sig.
Regression	79.509	4	19.877	98.574	0.000
Residual	76.021	377	0.202		
Total	155.530	381			

Further analysis revealed that three aspects of teacher technology usage (including professional development, communication, and administration) significantly predict principal digital leadership, as detailed in Table 4. Specifically, communication had the most significant impact on principal digital leadership, followed by professional development and administration. However, teaching dimension dose not contribute the principal digital leadership.

Table 4 Regression Coefficients, Observed T-Statistics, and P-value for the relationship between dimensions from teacher technology adoption and principal digital leadership

Variables	β	SE β	t	p
Professional development	0.166	0.162	2.825	0.005
Communication	0.407	0.390	6.032	<0.001
Teaching	0.102	0.098	1.809	0.071
Administration	0.149	0.144	2.442	0.015

5. Discussion

This study focuses on examining the impact of teacher technology adoption on principal digital leadership. The research questions center on analyzing this interaction process, with particular attention to the contributions of four dimensions: professional development, communication, teaching, and administration. Therefore, Pearson correlation coefficients and multiple linear regression analyses were employed. The results indicate a positive correlation between teacher technology adoption and principal digital leadership.

Regarding the relationship between teacher technology adoption and principal digital leadership, the result of this study is consistent with previous research. For example, the study by AlAjmi (2022) indicates a positive association between principal digital leadership and teacher technology usage. Similarly, a study conducted in the Chinese context also supports this conclusion (Luo, He, & Li, 2023). However, compared to the research by (Hero, 2020), this study found that principal digital leadership does not have a significant impact on teacher technology integration. This difference may be attributed to cultural variations: the cultural context of different countries or regions may influence the interaction styles and leadership approaches between principals and teachers, thereby affecting the effectiveness of digital technology integration. Additionally, this difference might be related to school size and type: the size of the school, its type (such as public or private), and its disciplinary setup could impact how technology is used and its effectiveness. Future research should consider these variables to gain a more comprehensive understanding of the relationship between digital leadership and technology adoption across different contexts.

Regarding the second research question, previous studies have not provided sufficient answers. However, in this research, the results revealed the impact of followers on leaders' behavior. In specific, the results indicated that teacher technology adoption significantly impact principal digital leadership practice, with the communication contributes most. This result has been proved by Loignon, Bergeron, and McKenna (2024), noted that effective communication is fundamental to improve leadership practice. Because through effective communication, teachers offer valuable insights and feedback that assist principals in making informed decisions (Goff, Guthrie, Goldring, & Bickman, 2014). To meet updated demands and challenges of digital age, digital leadership needs continuous adaptation. In this complex situation, it's a better way for principals to promptly identify potential issues and make strategic adjustments based on teachers' reflection and effective communication. The bidirectional flow of feedback also allows principals to respond more flexibly when developing digital strategies, ultimately boosting the effectiveness of digital management across educational institutions.

Meanwhile, professional development dimension is the second highest contribution to principal digital leadership practice. This is because as teachers continuously enhance their professional skills, they are better equipped to comprehend and support principals' digital leadership practices, contributing collaboratively to the digital transformation of educational institutions (Heap, Thompson, & Fein, 2021). Furthermore, the findings similarly indicated that teacher technology adoption in administrative activities influences principal digital leadership practices. Teachers can proficiently apply digital technology in school management and achieve significant results, they send positive signals regarding technology use to the principal (Starkey, 2020). This, in turn, shapes the principal's perception of the effectiveness and feasibility of technology adoption in school management. Such changes in perception not only bolster the principal's confidence in advancing digital leadership practices but also motivate them to actively embrace technological innovations, further optimizing the overall digital development strategies of the school. In a digital education environment, principals' leadership behaviors do not exist in isolation; rather, they are significantly influenced by the feedback and guidance derived from teachers' use of technology in administrative practices (Isik, 2023). Consequently, in advancing the digitalization of the school as a whole, more attention should be paid to teacher technology adoption in management activities and its reverse impact on leadership practice.

Surprisingly, teaching does not contribute to principal digital leadership practice. This may be because teachers use technology in teaching primarily to enhance instructional effectiveness and improve student learning experiences, which may not directly impact principals' leadership strategies and decisions. Compared to the other dimensions, teaching is more focused on teachers' influence on students. Moreover, the effects and experiences of teachers using technology in teaching may not be effectively communicated to principals through feedback mechanisms (Betancur-Chicué & García-Valcárcel Muñoz-Repiso, 2023). If there is a lack of effective feedback and communication channels, teachers' experiences and successes with technology use are unlikely to have a substantial impact on principals' decision-making. Teachers have a high degree of autonomy and independence in the classroom, whether they use technology in their teaching activities or not is personalized. Therefore, teachers may choose technology tools based on personal preferences and subject needs, but these choices may not necessarily affect the principals' digital decision-making and management.

6. Implication

The findings shift the perspective on digital leadership by emphasizing its interactive nature, moving beyond the traditional focus on the principal's influence on teacher behavior. This shift highlights the reciprocal processes that shape effective digital leadership. Theoretically, the research suggests a departure from traditional, principal-focused leadership models toward more reciprocal frameworks. Future studies should aim to refine and expand leadership theories that incorporate the reciprocal influence between teachers and principals, providing a deeper understanding of leadership evolution in university settings.

Meanwhile, the findings of this study offered several practical implications for school principals seeking to enhance their digital leadership through improved interactions with teachers. The strong contribution of communication to digital leadership highlights the importance of timely reflection and effective communication. The effective communication leads to more data-informed decisions that align with teachers' experiences. Based on the findings, universities should strengthen communication channels by establishing platforms like regular meetings and digital forums to capture teachers' feedback on technology use. The results also found continuous professional development is crucial for effective digital leadership. The findings suggest that universities should implement training programs that focus on both improving teacher skills and fostering a collaborative atmosphere that encourages principals' involvement. Additionally, principals can leverage teachers' use of technology in administrative tasks for strategic planning. However, although teachers' classroom technology use did not directly influence digital leadership, integrating structured feedback mechanisms to capture teaching outcomes can help principals align digital strategies with instructional practices.

Nonetheless, this research has some limitations. Since the sample was collected from universities in particular geographical and cultural contexts, the generalizability of the results may be restricted. Digital leadership practices and technology adoption challenges can differ widely depending on regional and cultural factors. Furthermore, the study relied on teachers' self-reported information, which may introduce subjective bias. Teachers and principals may either overstate or understate their technology use and leadership capabilities due to social desirability tendencies or biases in self-evaluation. Moreover, as the study utilized a cross-sectional design, it only captures the situation at a single point in time, without uncovering the evolving influence of teacher behaviors on principals' digital leadership. Future research should consider comparisons across diverse geographical and cultural backgrounds to improve the external validity of the findings. Incorporating observational data or third-party assessments alongside self-reported data would also enhance the accuracy and credibility of the results.

7. Conclusion

This paper has argued that teachers' use of digital technology influences principals' digital leadership behavior, clarifying how teachers, through their digital practices, drive and shape digital leadership within school leadership. When teachers actively engage in professional development, they not only enhance their own digital technology skills but also set an example of learning and innovation for the entire school. This cultural shift is crucial for fostering a digital leadership environment. Interestingly, the use of technology in teaching has the least impact on principals' digital leadership. Although integrating digital tools into teaching is vital for enhancing student learning experiences, this aspect seems to impact leadership behavior more indirectly through teaching outcomes rather than directly on leadership actions. Therefore, it seems that school management should establish more effective communication channels, allowing teachers' experiences and feedback on technology use to be promptly conveyed to principals. This would help principals make more targeted decisions to support and promote technology integration. Additionally, principals should increase their focus on teachers' professional development by providing ongoing training and development opportunities to enhance their ability to use technology effectively.

References

- [1] AlAjmi, M. K. (2022). The impact of digital leadership on teachers' technology integration during the COVID-19 pandemic in Kuwait. *International Journal of Educational Research*, 112, 101928.
- [2] Alexandro, R., & Basrowi, B. (2024). Measuring the effectiveness of smart digital organizations on digital technology adoption: An empirical study of educational organizations in Indonesia. *International Journal of Data and Network Science*, 8(1), 139-150.
- [3] Antonopoulou, H., Halkiopoulos, C., Barlou, O., & Beligiannis, G. N. (2021). Associations between traditional and digital leadership in academic environment: During the COVID-19 pandemic. *Emerging science journal*, 5(4), 405-428.
- [4] Berkovich, I., & Hassan, T. (2023). Principals' digital transformational leadership, teachers' commitment, and school effectiveness. *Education Inquiry*, 1-18.
- [5] Betancur-Chicué, V., & García-Valcárcel Muñoz-Repiso, A. (2023). Microlearning for the Development of Teachers' Digital Competence Related to Feedback and Decision Making. *Education Sciences*, 13(7), 722.
- [6] Crevani, L., Lindgren, M., & Packendorff, J. (2010). Leadership, not leaders: On the study of leadership as practices and interactions. *Scandinavian journal of management*, 26(1), 77-86.
- [7] Gesang, E., & Süß, S. (2021). A shift in perspective: Examining the impact of perceived follower behavior on leaders. *Scandinavian journal of management*, 37(2), 101156.
- [8] Goff, P., Guthrie, J. E., Goldring, E., & Bickman, L. (2014). Changing principals' leadership through feedback and coaching. *Journal of educational administration*, 52(5), 682-704.
- [9] Gronow, M. (2007). ICT leadership in school education. Australian Catholic University.
- [10] Hamzah, M. I. M. (2021). Digital Leadership: Way Forward For Islamic Education. Paper presented at the THE 1st PROCEEDING INTERNATIONAL CONFERENCE ISLAMIC EDUCATION (INCISED) 2021.
- [11] Heap, T., Thompson, R., & Fein, A. (2021). Designing teacher professional development programs to support a rapid shift to digital. *Educational Technology Research and Development*, 69, 35-38.
- [12] Hero, J. L. (2020). Exploring the Principal's Technology Leadership: Its Influence on Teachers' Technological Proficiency. *Online Submission*, 4(6), 4-10.
- [13] Isik, M. (2023). Investigation of School Administrators' Technological Leadership Behaviors in the Context of Teachers' Professional Development. *Malaysian Online Journal of Educational Technology*, 11(4), 238-257.
- [14] Karakose, T., Demirkol, M., Yirci, R., Polat, H., Ozdemir, T. Y., & Tülübaş, T. (2023). A conversation with ChatGPT about digital leadership and technology integration: Comparative analysis based on human-AI collaboration. *Administrative Sciences*, 13(7), 157.
- [15] Karakose, T., Polat, H., & Papadakis, S. (2021). Examining teachers' perspectives on school principals' digital leadership roles and technology capabilities during the COVID-19 pandemic. *Sustainability*, 13(23), 13448.
- [16] Laufer, M., Leiser, A., Deacon, B., Perrin de Brichambaut, P., Fecher, B., Kobsda, C., & Hesse, F. (2021). Digital higher education: a divider or bridge builder? Leadership perspectives on edtech in a COVID-19 reality. *International Journal of Educational Technology in Higher Education*, 18, 1-17.
- [17] Liu, P., Wang, X., & Liang, X. (2019). Understanding University President Leadership Research in China: A Review. *Frontiers of Education in China*, 14(1), 138-160.
- [18] Loignon, A., Bergeron, D., & McKenna, K. (2024). Leadership as Conversation.
- [19] Luo, W., He, H., & Li, H. (2023). Chinese Model of Digital Leadership in Early Childhood Settings: A Grounded Theory Study. *Early Education and Development*, 1-15.
- [20] Magagula, M. R. S. c., & Chikoko, V. (2025). Supporting Behaviour Management in Schools: Strategies Deployed by Head-Teachers. *International Journal of Educational Development*, 2(1), 01-12.
- [21] Oktavia, A., & Abimanto, D. (2024). Using Innovative Technologies in the Process of Teaching Maritime English. *International Journal of Educational Development*, 1(3), 61-68.
- [22] Rui, Z., Alias, B. S., Hamzah, M. I. M., & Wahab, J. A. (2024). The Impact of President Digital Leadership on Lecturer Technology Usage: The Mediating Role of Lecturer Digital Competence. *Educational Administration: Theory and Practice*, 30(4), 10210-10220.
- [23] Shin, J., Mollah, M. A., & Choi, J. (2023). Sustainability and Organizational Performance in South Korea: The Effect of Digital Leadership on Digital Culture and Employees' Digital Capabilities. *Sustainability*, 15(3).
- [24] Starkey, L. (2020). A review of research exploring teacher preparation for the digital age. *Cambridge Journal of Education*, 50(1), 37-56.
- [25] Sumardi, R., & Efendy, H. (2017). The role of leader, follower, and situation in leadership interaction in National University of Jakarta. *International Journal of Education*, 9(3), 211-221.
- [26] Tanucan, J. C. M., Negrido, C. V., & Malaga, G. N. (2022). Digital leadership of school heads and job satisfaction of teachers in the Philippines during the pandemic. *International Journal of Learning, Teaching and Educational Research*, 21(10), 1-18.
- [27] Velez, M. J., & Neves, P. (2022). A followership approach to leadership. *Journal of Personnel Psychology*.
- [28] Wang, Z., & Chu, Z. (2023). Examination of higher education teachers' self-perception of digital competence, self-efficacy, and facilitating conditions: An empirical study in the context of China. *Sustainability*, 15(14), 10945.

- [29] Wroblewski, D., Scholl, A., Ditrich, L., Pummerer, L., & Sassenberg, K. (2022). Let's stay in touch: Frequency (but not mode) of interaction between leaders and followers predicts better leadership outcomes. *PloS one*, 17(12), e0279176.
- [30] Xiao, J. (2019). Digital transformation in higher education: critiquing the five-year development plans (2016-2020) of 75 Chinese universities. *Distance Education*, 40(4), 515-533.
- [31] Yusof, M. R., Yaakob, M. F. M., & Ibrahim, M. Y. (2019). Digital leadership among school leaders in Malaysia. *International Journal of Innovative Technology and Exploring Engineering*.
- [32] Yuting, Z., Adams, D., & Lee, K. C. S. (2022). The relationship between technology leadership and teacher ICT competency in higher education. *Education and Information Technologies*, 27(7), 10285-10307. doi:10.1007/s10639-022-11037-0
- [33] Zeike, S., Bradbury, K., Lindert, L., & Pfaff, H. (2019). Digital leadership skills and associations with psychological well-being. *International journal of environmental research and public health*, 16(14), 2628.
- [34] Zhao, B. (2022). Research on the integration of traditional culture into the teaching of folk dance in colleges and universities. *Art and Performance Letters*, 3(3), 17-20.
- [35] Zhou, J., & Tse, A. W. C. (2023). The Effects of Kindergarten Principals' Digital Leadership on Teachers' Technology Integration during the COVID-19 Pandemic in Western China. Paper presented at the 2023 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALe).
- [36] Zhu, R., Alias, B. S., Hamzah, M. I. M., & Ab Hamid, M. R. (2024). A Threefold Examination of University Digital Leadership, Teacher Digital Competency, and Teacher Technology Behavior for Digital Transformation of Education. *International Journal of Learning, Teaching and Educational Research*, 23(10), 272-289.