The Influence of Principals' Leadership Styles and School Climate on Teacher Innovation in Digital-Based Learning in Elementary Schools

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Abstract
This study aims to examine the influence of the principal's leadership style and school climate on teacher innovation in digital-based learning in elementary schools in Cibatu District, Purwakarta Regency. The approach used is quantitative with correlational survey methods and multiple regression. The population in this study was 127 elementary school teachers, with a purposive sampling technique to select the entire population that was considered representative. The instrument used was a closed questionnaire that measured the variables of the principal's leadership style, school climate, and digital-based learning innovation. Data were collected and analyzed using SPSS for normality, linearity, correlation, regression, and significance tests. The results of the study showed that the principal's leadership style and school climate had a positive and significant influence on teachers' innovation in digital-based learning. Principals who adopt a transformational leadership style and create a collaborative school climate can encourage innovation in the use of technology in the classroom. The study also identified limitations such as focusing on one area and using only quantitative data. The implications of this study show the importance of the role of school principals in creating an environment that supports digital innovation. The suggestion was that principals need to adopt a more inclusive leadership style and provide ongoing digital training for teachers, as well as ensure adequate support for the application of technology in primary schools.

INTRODUCTION

In the era of VUCA (Volatility, Uncertainty, Complexity, Ambiguity) and the industrial revolution 4.0, digitalization is one of the most important aspects of the transformation of the world of education (Fengchao & Mingchi, 2023; Andri Soemitra et al., 2023). Rapid technological advances require the world of education to continue to adapt to these developments. One of the main challenges faced is how the education system can effectively utilize technology to improve the quality of learning. In the midst of this situation, the digitization of education at the elementary school level is very crucial, because it is the basis for students to recognize and utilize technology from an early age.

The introduction and implementation of digital-based learning in primary schools is essential to prepare students for future challenges. Digital-based education not only involves the use of technological tools, but also develops 21st-century skills such as creativity, collaboration, and problem-solving (Anasta et al., 2021). Thus, it is important for students in elementary school to get technology-based learning that can equip them with skills that are relevant to the times.

In the context of digital-based learning, the role of teachers has become very strategic. Teachers are the main key in integrating technology into the learning process. Without innovation

from teachers, even if technological tools are available, the use of technology in learning will still not be optimal (Pangestu et al., 2024). Therefore, teachers must be able to innovate, utilize technology to enrich learning, and create an engaging and effective learning experience for students.

Teachers' digital competence is very important to support the achievement of this goal. Important digital competencies for teachers include the ability to use digital tools effectively, design and manage technology-based learning, and be able to utilize digital resources to increase student engagement (Anasta et al., 2021). In addition, teachers must also have the ability to evaluate the use of technology in learning and adjust to the needs and characteristics of students (Perifanou et al., 2021; Promrub & Sanrattana, 2022). This competency is not only limited to the use of hardware or software, but also to the ability to apply technology in the context of appropriate pedagogy.

In Cibatu District, Purwakarta Regency, public elementary schools have started efforts to integrate technology in learning with the aim of forming graduates who have global insight and mastery of science and technology. This is in line with the existing educational vision and mission, which emphasizes on providing students with skills that are relevant to the times. However, although there have been efforts to implement digital-based learning, the reality is that there is a significant gap in terms of teachers' innovation ability to adapt technology in the classroom. Although most elementary schools in Cibatu District have made efforts to provide adequate technology facilities, such as digital devices and internet connections, there is still a significant gap in terms of teachers' ability to integrate such technology into the daily learning process. This is due to a variety of factors, such as a lack of adequate technical training, inconvenience in using new devices, and a limited understanding of how technology can improve students' learning experiences. Some teachers still find it difficult to use technology effectively, even when the device is available. This situation indicates the need for a more systematic approach to technology training, as well as ongoing support for teachers so that they can make the most of the potential of technology to improve the quality of learning and enrich teaching methods. The main factors that affect this low level of innovation are the lack of continuous training, lack of support from school principals, and limited access to adequate digital resources (Hutagalung & Purbani, 2021; Vermeulen et al., 2020).

Teachers' innovation in digital-based learning in elementary schools is influenced by various factors. Some of the external factors that play an important role in this include government policies, technological infrastructure, and training available to teachers (Haestetika et al., 2023). However, internal factors such as the principal's leadership style and school climate also play a huge role in encouraging or inhibiting this innovation (Sukmawati et al., 2024). Principals who have a clear vision of the importance of technology in education can motivate teachers to innovate and create a school climate that supports digital-based learning (Ali et al., 2021). A principal's leadership style that supports technology can create an environment that allows teachers to feel encouraged to experiment with digital tools in their learning (Khalid et al., 2022). In addition, a school climate that is open to change and supports the professional development of teachers is also very important in creating space for digital innovation. Principals who encourage the professional development of teachers and provide sufficient resources will facilitate the creation of innovative and technology-based learning.

Although there is a lot of research that examines the influence of leadership and school climate on educational innovation (AR & Sabandi, 2022; Dianawati et al., 2025; Hildayati, 2024), research linking these two factors to digital-based learning in primary schools is still limited. This research aims to fill this gap by exploring how the principal's leadership style and school climate can influence teacher innovation in digital-based learning, especially in elementary schools in Cibatu district, Purwakarta Regency. The urgency of this research is very large, considering the importance of digital competence in the world of education in today's digital era. This research is expected to provide insight for school principals, educators, and education policymakers on how to create an environment that supports digital innovation in elementary schools. It is hoped that the results of this

research can contribute to the development of more effective and affordable digital-based learning policies and strategies for elementary schools throughout Indonesia.

METHODS

This study uses a quantitative approach with the aim of examining the influence of the principal's leadership style and school climate on teacher innovation in digital-based learning in primary schools. The quantitative approach was chosen because it allows to obtain measurable and statistically analyzeable data (Anra & Yamin, 2017). Using this approach, this study aims to find out the extent of the influence of two independent variables, namely the principal's leadership style and school climate, on the dependent variable, namely digital-based learning innovation.

The method used in this study is a correlational survey method with multiple regression. The correlational method was used to measure the relationship between the independent variable (principal's leadership style and school climate) and the bound variable (digital-based learning innovation). Meanwhile, multiple regression is used to find out how much influence each independent variable has on the dependent variable (Akmalia et al., 2023). The variables of the principal's leadership style consist of eight dimensions, namely (1) transformational, (2) transactional, (3) autocratic, (4) democratic, (5) visionary, (6) charismatic, (7) executive, and (8) maternalistic (Remiswal et al., 2020; Sofyan Sauri, 2007; Sule & Priansa, 2018). School climate variables consist of three dimensions, namely (1) collaboration between teachers, (2) technological support, and (3) innovation culture (Angga & Wiyasa, 2021; Murti, 2016; Rahman et al., 2023). Meanwhile, the variables of digital-based learning innovation consist of three dimensions, namely (1) the use of new technology, (2) the development of interactive digital materials, and (3) the adaptation of collaborative learning methods (Hassan & Mirza, 2021; Innovation, 2016; OECD, 2016).

The population in this study consisted of 127 elementary school teachers in Cibatu District, Purwakarta Regency. The sampling technique used is purposive sampling, where the entire population is used as a research sample because the number is less than 150 people and is considered representative to be used as a sample (Arikunto, 2015). Data collection was carried out using a closed questionnaire consisting of statements related to the indicators of the principal's leadership style, school climate, and digital-based learning innovations. The measurement scale used to assess respondents' answers is a Likert scale with a score range of 1 to 5, which indicates the level of match or suitability of the response to the existing statement. The questionnaire instrument was developed based on the indicators that have been determined in the research variables. The questionnaire was then tested for construction, assessed by experts (expert judgement), and tested for validity and reliability to ensure its quality and reliability in measuring the variables studied.

After the data is collected, data analysis is carried out using SPSS software to obtain more accurate and structured results. The first step is to conduct a descriptive analysis to describe the basic characteristics of the data collected. Furthermore, an assumption test was carried out which included a normality test to check the distribution of data, a linearity test to ensure that the relationship between free and bound variables is linear, and a multicollinearity test to identify a high correlation between independent variables. After that, a correlation test is carried out to see the extent of the relationship between variables, followed by a significance test to test whether the relationship found has statistical significance. Finally, a determination test is used to measure how much an independent variable can explain a dependent variable. The results of this analysis are then interpreted and analyzed according to the score assessment criteria that have been set to draw conclusions relevant to the research objectives (Morning Star, 2021). Thus, the results of the multiple regression analysis will show how much influence the principal's leadership style and school climate have on teacher innovation in digital-based learning.

RESULTS AND DISCUSSION

Result

The Influence of Principals' Leadership Style on Teacher Innovation in Digital-Based Learning in Elementary Schools

To analyze the influence of the principal's leadership style on teacher innovation in digital-based learning in elementary schools, the hypotheses tested are as follows:

H_{01}: There is no influence of the principal's leadership style on teacher innovation in digital-based learning in elementary schools.

H_{a1}: There is an influence of the principal's leadership style on teacher innovation in digital-based learning in elementary schools.

The first step in testing the hypothesis of this study is to conduct a normality test and a linearity test on the collected data. The normality test was performed using the Kolmogorov-Smirnov test, while the linearity test was tested through ANOVA. The results of these two tests are presented in the table below:

Table 1. Normality Test and Linearity Test Results

Information	Testing	Asymp. Sig. (2-tailed)	Results
Normality Test	Normaliltas X1 Test	0,377	Normal Distribution
	Normaliltas X2 Test	0,784	Normal Distribution
	Normality test and	0,489	Normal Distribution
Linearity Test	Linearitas X1-Y	0,365	Linear
	Linearitas X2-Y	0,428	Linear

The results of the normality test and the linearity test showed that the data obtained was normally distributed and had a linear relationship. Therefore, to test the hypothesis, parametric tests are used, namely the F test and the regression test. The data analysis and hypothesis testing process was carried out using IBM SPSS Software version 24 for windows. The results of the analysis are presented as follows:

Table 2. Hypothesis Test 1

Model		Sum of Squares	df	Mean Square	F	Sig.
			ANOVA[a]			
1	Regression	55.360	1	55.360	78.483	.000[b]
	Residual	43.768	126	.154		
	Total	99.129	127			

a. Dependent Variable: Innovation
b. Predictors: (Constant), Leadership

Table 3. Regression Coefficient Test 1

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
			Coefficients[a]			
1	(Constant)	.843	.199		2.230	.027
	Leadership	.669	.046	.747	18.986	.000

a. Dependent Variable: Innovation

Table 4. Correlation and Determination 1

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
		Model Summary		
1	.639[a]	.409	.410	.39188

a. Predictors: (Constant), Leadership

Based on the results of the ANOVA test listed in Table 2, an F value of 78,483 with a significance of 0.000 was obtained. Because the significance value is less than 0.05, H0 stating that

there is no influence of the principal's leadership style on teacher innovation in digital-based learning in elementary schools can be rejected. Instead, Ha is accepted, which means that there is a positive and significant influence between the principal's leadership style on teacher innovation in digital-based learning.

In Table 4, the R value obtained was 0.639, which shows a fairly strong relationship between the principal's leadership style and teacher innovation in digital-based learning. The R Square value of 0.409 indicates that about 40.9% of the variability of teacher innovation in digital-based learning can be explained by the principal's leadership style. Meanwhile, the Adjusted R Square value of 0.410 shows that the regression model used is quite good in explaining the influence of independent variables on dependent variables. With an R Square of 0.409, the 40.9% variation in teacher innovation in digital-based learning can be explained by the influence of the principal's leadership style. The rest, 59.1%, could be influenced by other factors not measured in this study.

Based on the results of the regression coefficient test shown in Table 3, the regression equations formed are:

Y = 0.843 + 0.669 X1

Information:

Y = teacher innovation in digital-based learning.

X1 = the principal's leadership style.

The coefficient of 0.669 in the principal's leadership style variable shows that every one unit increase in the principal's leadership style will increase teacher innovation in digital-based learning by 0.669 units. A very low significance value (0.000) indicates that this coefficient is statistically significant.

The Influence of School Climate on Teacher Innovation in Digital-Based Learning in Elementary Schools

To analyze the influence of school climate on teacher innovation in digital-based learning in elementary schools, the hypotheses tested are as follows:

H_{02}: No influence of school climate on teacher innovation in digital-based learning in primary schools.

H_{a2}: There is an influence of school climate on teacher innovation in digital-based learning in primary schools.

The test of the research hypothesis was carried out by calculating the values of the correlation coefficient, significance level, determination coefficient and regression analysis with the help of IBM SPSS version 24 for windows software. The results of the analysis are presented as follows:

Table 5. Hypothesis Test 2

Model		Sum of Squares	df	Mean Square	F	Sig.
		ANOVA[a]				
1	Regression	2.022	1	2.022	47.719	.000[b]
	Residual	1.767	126	.054		
	Total	3.789	127			

a. Dependent Variable: innovation
b. Predictors: (Constant), Climate

Table 6. Regression Coefficient Test 2

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		Coefficients[a]				
		B	Std. Error	Beta		
1	(Constant)	1.114	.716		4.193	.000
	Komunikasi_X1	.493	.087	.781	6.845	.000

a. Dependent Variable: Innovation

Table 7. *Correlation and Determination 2*

		Model Summary		
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.631[a]	.398	.419	.23141

a. Predictors: (Constant), Climate

Based on the results of the ANOVA test contained in Table 5, the F value obtained was 47.719 with a significance of 0.000. Because the significance value is less than 0.05, H0 stating that there is no influence of school climate on teacher innovation in digital-based learning in elementary schools can be rejected. On the other hand, Ha, who stated that there is a positive and significant influence of the school climate on teacher innovation in digital-based learning, was accepted. Thus, there is a significant influence between the school climate and teacher innovation in digital-based learning.

In Table 7, the R value obtained was 0.631, which shows a fairly strong relationship between the school climate and teacher innovation in digital-based learning. An R-Square value of 0.398 indicates that about 39.8% of the variation in teacher innovation in digital-based learning can be explained by the influence of the school climate. Meanwhile, the Adjusted R Square value of 0.419 shows that the regression model used is quite good in explaining the influence of school climate on teacher innovation in digital-based learning. With an R Square value of 0.398, 39.8% of the variation in teacher innovation in digital-based learning can be explained by the school climate. The remainder, 60.2%, was influenced by other factors not described in the study.

Based on the results of the regression coefficient test listed in Table 6, the regression equations formed are:

Y= 1.114 + 0.493 X2

Information:

Y : Teacher innovation in digital-based learning

X2 : School climate

The coefficient of 0.493 in the school climate variable shows that every one unit increase in the school climate will increase teacher innovation in digital-based learning by 0.493 units. A very low significance value (0.000) indicates that this coefficient is statistically significant.

The Influence of Principals' Leadership Styles and School Climate on Teacher Innovation in Digital-Based Learning in Elementary Schools

To analyze the influence of the principal's leadership style and school climate on teacher innovation in digital-based learning in elementary schools, the hypotheses tested are as follows:

$H0_3$: There is no influence of the principal's leadership style and school climate on teacher innovation in digital-based learning in primary schools.

Ha_3: There is an influence of the principal's leadership style and school climate on teacher innovation in digital-based learning in elementary schools.

The test of the research hypothesis was carried out by calculating the values of the correlation coefficient, significance level, determination coefficient and regression analysis with the help of IBM SPSS version 24 for windows software. The results of the analysis are presented as follows:

Table 8. Hypothesis Test 3

		ANOVA[a]				
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.160	2	1.130	17.066	.006[b]
	Residual	1.429	125	.954		
	Total	3.989	127			

a. Dependent Variable: innovation

b. Predictors: (Constant), Leadership, Climate

Table 9. Regression Coefficient Test 3

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.874	.716		4.193	.000
	Leadership	.493	.087	.781	6.845	.000
	Climate	.763	.387	.181	4.145	.040

Coefficients[a]

a. Dependent Variable: Innovation

Table 10. Correlation and Determination 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.769[a]	.591	.559	.23141

a. Predictors: (Constant), Leadership, Climate

Based on the results of the ANOVA test listed in Table 8, the calculated F value obtained is 17,066 with a significance value of 0.006. Because the significance value is less than 0.05, H03 states that there is no influence between the principal's leadership style and the school climate on teacher innovation in digital-based learning in elementary schools can be rejected. Instead, Ha3 is accepted, which means that there is a positive and significant influence between the principal's leadership style and the school climate on teacher innovation in digital-based learning.

In Table 10, the R value obtained was 0.769, which shows a strong relationship between the two independent variables (principal's leadership style and school climate) and teachers' innovation in digital-based learning. An R-Square value of 0.591 indicates that approximately 59.1% of the variation in teacher innovation in digital-based learning can be explained by the principal's leadership style and school climate. Meanwhile, the Adjusted R Square value of 0.559 shows that the regression model used is quite good in explaining the influence of the two independent variables on teacher innovation. With an R Square value of 0.591, the 59.1% variation in teacher innovation in digital-based learning can be explained by the influence of the principal's leadership style and the school climate. The rest, 40.9%, was influenced by other factors not measured in this study.

Based on the results of the regression coefficient test listed in Table 9, the regression equations formed are:

Y = 1.874 + 0.493 X1 + 0.763 X2

Information:

Y : Teacher innovation in digital-based learning.

X1 : The principal's leadership style.

X2 : School climate.

The coefficient of 0.493 for the principal's leadership style (X1) shows that every one-unit improvement in the principal's leadership style will increase teacher innovation in digital-based learning by 0.493 units. Meanwhile, the coefficient of 0.763 for school climate (X2) shows that every one unit increase in school climate will increase teacher innovation by 0.763 units. The very low significance value (0.000 for the principal's leadership style and 0.040 for the school climate), suggests that both variables have a very significant influence on teacher innovation in digital-based learning.

Discussion

Teacher innovation in digital-based learning in primary schools is an important aspect that is receiving great attention, driven by the need to adapt educational practices to the rapid development of technology. This innovation is closely related to the theory of Innovation Diffusion put forward by Everett Rogers, which provides an important framework for understanding the application of

innovation by teachers in digital learning in elementary schools. Rogers' theory of innovation diffusion describes the process of disseminating new ideas and technologies, by highlighting the role of innovators, early adopters, and other stakeholders in the innovation process (Unasiansari et al., 2024). In the context of education, particularly in relation to digital-based learning, Rogers encourages teachers to adopt new digital tools and be ready to change their teaching practices to integrate them effectively. This diffusion of innovation emphasizes how new teaching and digital tools are adopted and implemented by educators (Oestreich & Guy, 2023). The relevance of this theory is evident from the significant relationship between teachers' perceptions of digital technology and their willingness to innovate. Factors such as ease of use and perceived benefits of digital devices greatly influence the adoption of technology in learning innovation by teachers (Fasha & Sopandi, 2024). Thus, digital-based learning can increase engagement and interactivity, which supports a wide range of learning styles and needs. However, it also requires teachers to have good digital literacy and readiness to adopt innovative practices.

This research shows a positive and significant influence of the principal's leadership style and school climate on teacher innovation in digital-based learning in primary schools. These findings are in line with Lamusu et al (2023) who affirm that there is a significant relationship between principal leadership and school climate on teacher performance (Lamusu et al., 2023). Principal's transformational leadership is essential in creating an innovative and supportive learning environment where teachers feel valued and motivated to implement new teaching methods, including the use of digital technology. In the research of Haestetika et al (2023), it is proven that good leadership of school principals can increase teacher motivation and innovation, which is crucial in facing learning challenges in the digital era. School leaders who are committed to creating a shared vision and providing the necessary support will encourage teachers to dare to try new approaches to learning.

A positive school climate also contributes greatly to creating an environment conducive for teachers to innovate. If principals create an open and collaborative atmosphere, then teachers will be more likely to innovate in the way they teach. In a study (Sayman & Atienzar, 2023), it was found that an improvement in the school climate is also in line with improved teacher performance, which suggests that when the environment in schools is more supportive, teachers will be more confident in implementing digital approaches in their teaching. Therefore, it is important for the principal to not only emphasize academic outcomes, but also to build strong and supportive relationships between all staff members.

Transformational leadership styles, which involve teacher inspiration and empowerment, have been shown to be effective in increasing teacher motivation and innovation. Research by Lusterio & Arnejo (2023) shows that principals who adopt a transformational leadership style tend to create a collaborative and innovative work atmosphere, where teachers feel empowered to try new methods and digital technologies in their learning. In addition, a visionary leadership style also contributes to teacher innovation, where principals who are able to create a clear vision of the use of digital technology in the curriculum will help teachers direct their energy towards achieving those goals; Although specific references to this statement are not included, research shows the importance of vision in educational leadership.

On the other hand, a positive school climate, which is often determined by the principal's leadership style, has a significant impact on teacher performance and innovation. A democratic leadership style, for example, allows for teachers' involvement in decision-making, thereby increasing their commitment and dedication to innovation in digital-based learning (Nazneen et al., 2024). When teachers feel valued and involved in the decision-making process, they tend to be more open to new and innovative ideas. In contrast, autocratic leadership styles can result in a negative school climate, where teachers feel pressured and not motivated to innovate (Batool et al., 2023). Therefore, school principals need to adopt a supportive and stimulating leadership style, thereby creating a conducive environment for teachers to explore and implement digital innovations in the classroom learning process.

In the context of impactful innovation, the support of school principals in providing the necessary resources and training for teachers is essential. Teachers who are equipped with adequate facilities and technology training will be better able to implement digital-based learning effectively (Li et al., 2024). For example, during the pandemic that hit Indonesia, schools had to adapt to distance learning. In such situations, the principal plays an important role in facilitating this transition by providing the necessary technical and pedagogical support (Warner et al., 2023). Thus, the combination of strong leadership, a positive school climate, and adequate resource support will encourage teacher innovation in digital-based learning, thereby improving the quality of education in primary schools.

The obstacles and challenges in implementing leadership that supports teacher innovation in digital-based learning in elementary schools are very diverse and complex. One of the main challenges faced by school principals is the lack of adequate technological facilities and infrastructure to support the implementation of digital learning. Mubarok et al (2023) show that limited access to educational technology, such as hardware and unstable internet connections, can hinder the use of technology by teachers and reduce the effectiveness of digital learning. In addition, the lack of comprehensive training for teachers on the use of digital technology is also an obstacle, which causes teachers to feel less confident and have difficulty in implementing innovative learning methods. In addition, aspects of school culture also play an important role in influencing the success of innovation. If the school climate is not supportive and there is no effective communication between the principal and the teacher, then this can create an unproductive work atmosphere and reduce the motivation of teachers to innovate.

Leadership style, while it can make a positive contribution, can also be a challenge in itself. For example, an autocratic leadership style can cause dissatisfaction among teachers and hinder them from coming up with new ideas (Lamusu et al., 2023). This research shows that effective leadership and a supportive school climate can increase the success of implemented innovations (Lamusu et al., 2023). Therefore, principals need to address these challenges by adopting an inclusive leadership approach, which can create a collaborative environment and encourage innovation. In addition, school principals must also ensure adequate training and facilities for teachers, so that they can successfully implement digital learning effectively.

Efforts to increase teacher innovation in digital learning in elementary schools can be done through the implementation of effective transformational leadership by school principals, where school principals function to inspire and empower teachers in implementing digital technology in the classroom (Andriadi & Sulistiyo, 2024). Transformational leadership includes aspects such as inspirational motivation and individual attention, which are capable of creating an environment that supports innovation (Addin et al., 2020; Septiani & Kejora, 2021). In this context, principals should actively encourage teachers to develop their digital skills through regular training and professional development, as well as provide them with access to relevant digital resources. The implementation of this strategy not only increases teachers' confidence in the use of technology, but also encourages collaboration among them, thereby creating an atmosphere conducive to innovation and the application of more interactive and interesting learning methods for students.

In addition, it is important for school principals to develop a positive and inclusive school climate, where teachers feel valued and supported in carrying out digital innovations (Irawan et al., 2024). This can be done by involving teachers in decision-making related to the use of technology in the classroom and rewarding their efforts in integrating digital tools in learning. Thus, approaches that involve collaboration and open communication can significantly encourage teacher innovation in digital learning. In order to achieve this goal, school leaders need to ensure that policies are in place that support the development of innovative cultures, where teachers are encouraged to experiment and receive constructive feedback to improve the quality of their teaching in the ever-evolving digital age.

CONCLUSION

The principal's leadership style and school climate have a significant influence on teachers' innovation in digital-based learning in elementary schools. This research shows that a principal's transformational leadership style, which includes inspirational motivation and individualized attention, can encourage teachers to develop their digital skills and integrate technology in learning more effectively. Principals who have a clear vision of the importance of technology in education can create an environment conducive to innovation. In addition, a school climate that is supportive, open to change, and collaborative, also plays an important role in encouraging teachers to innovate. The positive influence found in this study shows that a combination of supportive leadership style and a collaborative school climate can encourage teachers to be more courageous in adopting technology in digital-based learning. Principal support that includes the provision of ongoing training and adequate resources is key to the successful implementation of digital innovation. These findings are in line with the theory of Innovation Diffusion which states that a supportive environment, both in the form of visionary leadership and an open school climate, will increase the adoption of technology by teachers. On the other hand, challenges such as limited infrastructure and inadequate training are still obstacles in the implementation of digital innovations in the classroom. Therefore, policies that strengthen teachers' digital capacity and educational infrastructure are needed to support the sustainability of this innovation. Overall, principals need to adopt an inclusive and empowering leadership approach, as well as create a school culture that supports experimentation and collaboration between teachers. Thus, innovations in digital-based learning can be more optimally applied in elementary schools, which in turn will improve the quality of education in this digital era.

REFERENCES

Addin, F. N., Bintang Kejora, M. T., & Kosim, A. (2020). Pengaruh Kepemimpinan Transformasional Kepala Madrasah Terhadap Kinerja Guru Di Madrasah Aliyah Ghoyatul Jihad Kabupaten Karawang. *Idaarah: Jurnal Manajemen Pendidikan*, *4*(2), 153. https://doi.org/10.24252/idaarah.v4i2.16673

Akmalia, R., Nur Nst, W., & Siahaan, A. (2023). Influence of Self-Efficacy, Organizational Culture, and Job Satisfaction on The Performance of Madrasah Aliyah Teachers. *Nidhomul Haq : Jurnal Manajemen Pendidikan Islam*, *8*(3), 437–453. https://doi.org/10.31538/ndh.v8i3.4091

Ali, A. K., Saleh, M., & Aslamiah, A. (2021). Contribution of the Principal's Transformational Leadership and School Climate on Teacher Performance Through Work Motivation. *Journal of K6 Education and Management*, *4*(1), 81–90. https://doi.org/10.11594/jk6em.04.01.08

Anasta, N. D. C., Darmayanti, M., & Hendriani, A. (2021). Elementary School Teacher Competency Development in Creating Digital Learning Media Anchor App Based. *Indonesian Journal of Primary Education*, *5*(2), 132–140. https://doi.org/10.17509/ijpe.v5i2.39017

Andri Soemitra, N., Lubis, A. S., Ratna Sari Dewi, N., & Debbi Chyntia Ovami, N. (2023). Essential Hard Skill for Student in VUCA Era: Literature Study. *Journal of Trends Economics and Accounting Research*, *3*(4), 605–610. https://doi.org/10.47065/jtear.v3i4.634

Andriadi, D., & Sulistiyo, U. (2024). The Influence of Transformational and Instructional Leadership Styles of School's Principals on Teacher's Performance, Motivation, Job Satisfaction and Student Achievement in Primary and Secondary Schools. *PPSDP International Journal of Education*, *3*(2), 536–548. https://doi.org/10.59175/pijed.v3i2.335

Angga, I. M. D., & Wiyasa, I. K. N. (2021). Kontribusi Kepemimpinan Kepala Sekolah Dan Iklim Kerja Terhadap Kinerja Guru. *Jurnal Pedagogi Dan Pembelajaran*, *4*(1), 14. https://doi.org/10.23887/jp2.v4i1.32309

Anra, Y., & Yamin, M. (2017). Relationships between lecturer performance, organizational culture, leadership, and achievement motivation. *Foresight and STI Governance*, *11*(2), 92–97. https://doi.org/10.17323/2500-2597.2017.2.92.97

AR, N. R., & Sabandi, A. (2022). The Effect of School Principal Leadership and School Climate on

Teacher Performance. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*, *7*(2), 411. https://doi.org/10.31851/jmksp.v7i2.7572

Arikunto, S. (2015). *Prosedur Penelitian,*. Rineka Cipta.

Batool, I., Jabeen, S., & Ali, S. Z. (2023). Perceived Effectiveness of Leadership Styles for Improvement in Public Schools of Punjab. *Journal of Social Sciences Advancement*, *4*(1), 37–45. https://doi.org/10.52223/jssa23-040106-62

Bintang Kejora, M. T. (2021). *STATISTIK MANAJEMEN PENDIDIKAN: TEORI DAN PRAKTIK BERBASIS SOFTWARE SPSS* (1th ed.). Yayasan Sahabat Alam Rafflesia.

Dianawati, R., Endah, L., Ningrum, C., & Hadi, S. (2025). Exploring Leadership Styles and Their Impact on Innovation in TVET: Insights from a Systematic Analysis. *IJORER : International Journal of Recent Educational Research*, *6*(1), 183–205.

Fasha, L. H., & Sopandi, W. (2024). Analysis of Teaching Material: To What Extent Are Students' Argumentation Learning. *Advances in Social Science, Education and Humanities Research*, 285–292. https://doi.org/10.2991/978-2-38476-206-4_32

Fengchao, X., & Mingchi, J. (2023). School Leadership and Management Innovation in the Internet+ Education Era. *International Journal of New Developments in Education*, *5*(12). https://doi.org/10.25236/ijnde.2023.051205

Haestetika, M., Marsudin, S., Anisah, A., & Sulastri, S. (2023). The Influence of Principal's Transformational Leadership and Work Motivation on Teacher Innovation at State Elementary Schools in Bukittinggi City. *International Journal of Humanities Education and Social Sciences (Ijhess)*, *3*(1). https://doi.org/10.55227/ijhess.v3i1.505

Hassan, M. M., & Mirza, T. (2021). The Digital Literacy in Teachers of the Schools of Rajouri (J&K)-India: Teachers Perspective. *International Journal of Education and Management Engineering*, *11*(1), 28–40. https://doi.org/10.5815/ijeme.2021.01.04

Hildayati. (2024). The Influence of Principal Instructional Leadership, School Climate, and Work Motivation on Teacher Professionalism in Public High Schools throughout Barito Kuala Regency. *EduLine: Journal of Education and Learning Innovation*, *4*(1), 53–67. https://doi.org/10.35877/454ri.eduline2377

Hutagalung, B., & Purbani, W. (2021). The Ability of Digital Literacy for Elementary School Teachers. *Jpi (Jurnal Pendidikan Indonesia)*, *10*(4). https://doi.org/10.23887/jpi-undiksha.v10i4.32938

Innovation, E. (2016). *Innovating Education and Educating for Innovation*. OECD Publishing. https://doi.org/10.1787/9789264265097-en

Irawan, A. C., Wijaya, S., & Jaolis, F. (2024). Pengaruh Transformational Leadership Terhadap Teacher Performance Pada Sekolah Kristen Dengan School Climate Sebagai Variabel Mediasi. *Jamp Jurnal Administrasi Dan Manajemen Pendidikan*, *7*(1), 122. https://doi.org/10.17977/um027v7i12024p122

Khalid, S., Karaki, W., Hasan, R. A., Chang, B.-L., Shaikh, J. M., & Kanwal, W. (2022). Teachers' Psychological Resistance to Digital Innovation in Jordanian Entrepreneurship and Business Schools: Moderation of Teachers' Psychology and Attitude Toward Educational Technologies. *Frontiers in Psychology*, *13*. https://doi.org/10.3389/fpsyg.2022.1004078

Lamusu, Y., Ansar, A., & Suking, A. (2023). Hubungan Kepemimpinan Pembelajaran Kepala Sekolah Dan Iklim Sekolah Terhadap Kinerja Guru. *Student Journal of Educational Management*, 1–12. https://doi.org/10.37411/sjem.v3i1.1683

Li, K., Wijaya, T. T., Chen, X., & Harahap, M. S. (2024). Exploring the Factors Affecting Elementary Mathematics Teachers' Innovative Behavior: An Integration of Social Cognitive Theory. *Scientific Reports*, *14*(1). https://doi.org/10.1038/s41598-024-52604-4

Lusterio, C. G. C., & Arnejo, J. M. (2023). School Administrators' Leadership Styles and Teachers' Performance. *International Journal of Research Publications*, *127*(1). https://doi.org/10.47119/ijrp1001271620235045

Mubarok, M. S., Kurniasih, N., & Qomaruzzaman, B. (2023). Fasilitas Belajar, Teknologi Pendidikan, Dan Penerapannya Dalam Pembelajaran PAI: Menuju Pendidikan 4. *Jiip - Jurnal Ilmiah Ilmu Pendidikan*, *6*(11), 9287–9297. https://doi.org/10.54371/jiip.v6i11.3165

Murti, Y. (2016). Pengaruh motivasi kerja guru, iklim kerja dan kepemimpinan kepala sekolah terhadap kinerja guru Sekolah Dasar Negeri di Kecamatan Kota Mukomuko. *Universitas Terbuka*. https://repository.ut.ac.id/6932/1/42709.pdf

Nazneen, N., Khan, U. A., Raheem, A., & Khan, F. A. (2024). Mediating Role of School Climate Between Democratic Leadership Style and Teachers' Professional Commitment. *Journal of Policy Research*, *10*(2), 158–164. https://doi.org/10.61506/02.00218

OECD. (2016). *Innovating Education and Educating for Innovation*. https://doi.org/10.1787/9789264265097-en

Oestreich, J. H., & Guy, J. W. (2023). Technology Personalities in the Classroom: A New Classification System of TechTypes From Expert to Techy Turtle. *Pharmacy*, *11*(3), 91. https://doi.org/10.3390/pharmacy11030091

Pangestu, D. A., Islami, S. A. P., & Maylinda, P. (2024). Transformational Leadership and Proactive Personality on Innovative Behavior Among High School Teachers in Cirebon City. *Journal Research of Social Science Economics and Management*, *3*(9), 1743–1753. https://doi.org/10.59141/jrssem.v3i9.640

Perifanou, M., Economides, A. A., & Tzafilkou, K. (2021). Teachers' Digital Skills Readiness During COVID-19 Pandemic. *International Journal of Emerging Technologies in Learning (Ijet)*, *16*(08), 238. https://doi.org/10.3991/ijet.v16i08.21011

Promrub, S., & Sanrattana, W. (2022). Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills. *Education Quarterly Reviews*, *5*(2). https://doi.org/10.31014/aior.1993.05.02.506

Rahman, S., Hermanto, H., & Saufi, A. (2023). Pengaruh Iklim Organisasi Dan Kompensasi Terhadap Loyalitas Guru Honor Dengan Dimediasi Kepuasan Kerja (Studi Pada SMKN Se Kota Mataram). *Empiricism Journal*, *4*(1), 19–34. https://doi.org/10.36312/ej.v4i1.1216

Remiswal, R., Hasbi, F., & Diani, Y. P. (2020). Model Kepemimpinan Di Pondok Pesantren. *Produ Prokurasi Edukasi Jurnal Manajemen Pendidikan Islam*, *2*(1). https://doi.org/10.15548/p-prokurasi.v2i1.2052

Sayman, A. M., & Atienzar, E. A. (2023). Influence of School Climate and Leadership Style of Principals on the Performance of Public Elementary Teachers During the Covid-19 Pandemic. *American Journal of Multidisciplinary Research and Innovation*, *2*(2), 58–63. https://doi.org/10.54536/ajmri.v2i2.1325

Septiani, A., & Kejora, M. T. B. (2021). *EDUKATIF : JURNAL ILMU PENDIDIKAN Tingkat Aktivitas Belajar Siswa pada Pembelajaran Online Pendidikan Agama Islam di Masa*. *3*(5), 2594–2606.

Sofyan Sauri. (2007). Kepemimpinan Pendidikan Berbasis Nilai: Membangun Kembali Komitmen, Kinerja Dan Produktivitas Pendidik Dan Tenaga Kependidikan. *Disampaikan Pada Pelatihan Kependidikan Di Kampus Politeknik UNSI Sukabumi Tanggal 29 Desember 2007*, 1–12.

Sukmawati, M., Giatman, M., & Maksum, H. (2024). E-Leadership: Concept and Influence of Digital Leadership. *Jurnal Teknologi Informasi Dan Pendidikan*, *17*(1), 87–97. https://doi.org/10.24036/jtip.v17i1.811

Sule, E. T., & Priansa, D. J. (2018). *Kepemimpinan dan Perilaku Organisasi Membangun Organisasi Unggul di Era Perubahan*. Refika Adhitama.

Unasiansari, I., Sarwoprasodjo, S., Hubeis, A. V. S., & Kinseng, R. A. (2024). Investigating Teacher's Digital Technology Use Through a Modified Technology Acceptance Model Framework: A Survey in Indonesia Capital City Buffer Areas. *Revista De Gestão Social E Ambiental*, *18*(9), e07679. https://doi.org/10.24857/rgsa.v18n9-146

Vermeulen, M., Kreijns, K., & Evers, A. T. (2020). Transformational Leadership, Leader–member

Exchange and School Learning Climate: Impact on Teachers' Innovative Behaviour in the Netherlands. *Educational Management Administration & Leadership*, *50*(3), 491–510. https://doi.org/10.1177/1741143220932582

Warner, S. C., Mohammed, J., & Borde, M. G.-L. (2023). From Traditional to Home-Based Learning: Challenges of Elementary School Teachers During COVID-19 in Trinidad and Tobago. *International Journal of Innovation in Teaching and Learning (Ijitl)*, *8*(2), 1–19. https://doi.org/10.35993/ijitl.v8i2.1506