Empowering Primary Education: The Synergy of Virtual Supervision and Transformational Leadership in Boosting Teacher Self-Efficacy and Learning Outcomes

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Abstract

This study focuses on analyzing the influence of principal leadership and virtual classroom-based supervision on learning effectiveness in elementary schools, with teachers' self-efficacy serving as a mediating variable. The main objective of this research is to examine how the combination of effective leadership and the integration of technology in supervision can enhance the quality of learning. The study employs a survey method with a causality approach, gathering data from 200 elementary school teachers in Jakarta. Data analysis was conducted using Structural Equation Modeling (SEM) facilitated by AMOS 24 software, which enables the examination of both direct and indirect relationships between the variables. The findings reveal that principal leadership and virtual classroom-based supervision significantly impact learning effectiveness, with teachers' self-efficacy reinforcing these effects. These results suggest that leveraging technology in supervision and fostering leadership development in schools are effective strategies for improving learning outcomes. The implications of this study contribute significantly to the formulation of innovative and technology-driven educational policies, which can be utilized to enhance the quality of education at the primary school level.

INTRODUCTION

In the increasingly advanced digital era, the world of education faces complex challenges in maintaining learning effectiveness, especially in elementary schools. This phenomenon became a serious concern when educational leadership and traditional supervision methods proved to be no longer sufficient to overcome the new dynamics in the teaching and learning process (Bai & Liu, 2021; Martin et al., 2021; Tan et al., 2022). The need to implement more innovative approaches, such as virtual classroom-based supervision, is becoming increasingly urgent (Bates et al., 2021; Dennis & Stockley, 2021; Wang et al., 2022). The use of technology in education has shown great potential in improving the quality of learning, but its application is still limited and uneven (Kong et al., 2021; Pettersson & Olofsson, 2021; Sun et al., 2022).

This social fact suggests that there is a gap between the actual needs in the field and existing educational practices, which, if not addressed immediately, can have a negative impact on the quality of education in the long term (Johnson et al., 2021; Lee et al., 2021; Voogt & Knezek, 2021). Additionally, the integration of cultural and local wisdom in educational practices, particularly in Islamic education, can provide a more holistic approach to addressing these challenges (Chuanchen, 2023; Maulidah et al., 2023; Hasanah & Hefniy, 2023). Transformational leadership theory and self-efficacy theory provide a strong theoretical foundation for understanding how teachers' leadership roles and self-efficacy can affect learning effectiveness (Northouse, 2021; Schunk & DiBenedetto, 2021; Wang & Degol, 2021). Transformational leadership emphasizes the importance of principals in inspiring and empowering teachers to achieve higher performance (Berkovich & Eyal, 2021; Day et al., 2021; Kovač et al., 2021).

On the other hand, theory of self-efficacy states that teachers' confidence in their teaching ability greatly determines the success in managing the classroom and implementing effective learning strategies (Bandura et al., 2021; Goddard et al., 2021; Tschannen-Moran & Gareis, 2021). Both of these theories are relevant in today's educational context, where innovation and adaptation to change are key to success (Avolio et al., 2021; Jones et al., 2021; Robinson et al., 2021). Furthermore, the role of Islamic educational management in fostering these principles highlights the significance of internalizing religious values alongside educational innovations (Rusdi et al., 2022; Norman & Paramansyah, 2024; Hamidah, 2023). Thus, this study is important to understand how the combination of effective leadership and increasing teachers' self-efficacy through technology-based supervision can improve the quality of education in primary schools (Sun et al., 2021; Yang et al., 2021; Zhu & Liu, 2021).

This study addresses the impact of principal leadership and virtual classroom-based supervision on learning effectiveness in elementary schools, with a particular focus on teachers' self-efficacy as a mediating variable. While technology has been widely integrated into classroom instruction, its application in school supervision remains limited, especially in elementary schools. This raises critical questions about whether such an approach can effectively enhance teachers' self-efficacy and improve learning outcomes. The issue is particularly urgent in the context of Jakarta's elementary schools, where disparities in technological infrastructure and varying levels of support for teachers create significant challenges.

These challenges are exacerbated by the diverse socioeconomic backgrounds of students and the large class sizes often found in Jakarta's public schools, making it difficult to implement effective supervision and leadership practices. Without targeted interventions, these factors may contribute to a decline in educational quality, especially as schools continue to adapt to the demands of distance learning and the broader digital transformation in education.

Previous research has explored various aspects related to leadership, teacher self-efficacy, and learning effectiveness. For example, research conducted by Liu et al. (2020) showed that transformational leadership has a significant positive influence on teacher motivation and performance, ultimately improving student learning outcomes. On the other hand, research by Ainscow and Sandill (2021) found that technology-supported supervision can help overcome the limitations of traditional supervision by providing teachers with faster and more accurate feedback.

This study also shows that increasing teachers' self-efficacy is the key to implementing more effective learning methods. However, research by Kraft and Blazar (2020) notes that while technology has great potential, there are still challenges in its widespread application in primary schools, especially in the context of supervision. From this literature review, it appears that there is a need for further research integrating these variables in one comprehensive causality model, to explore how they interact with each other and affect learning effectiveness.

Although previous research has identified the importance of leadership and self-efficacy in education, there have not been many studies explicitly exploring how virtual classroom-based supervision can mediate the relationship between leadership and learning effectiveness. This gap is becoming increasingly evident in the context of primary schools, where the unique challenges in the application of technology are often overlooked. This research will fill the gap by examining a causality model that includes principal leadership, virtual classroom-based supervision, and teacher self-efficacy as factors that affect learning effectiveness. Thus, this research will not only make a significant theoretical contribution, but also offer practical guidance for educators and policymakers in designing more effective interventions to improve the quality of education.

The novelty of this research lies in the integration of a virtual classroom-based supervision approach with leadership theory and self-efficacy in the context of basic education. Unlike previous studies that tend to focus on one aspect only, this study proposes a holistic and comprehensive model to understand the dynamics between leadership, supervision, and self-efficacy in influencing learning effectiveness. In addition, this research will also explore the application of technology in educational supervision, which is still rarely researched, especially in the context of elementary schools in Indonesia. Thus, this research is expected to provide a new perspective that has not been widely discussed in the literature, as well as offer innovative solutions to improve the quality of education in the digital era.

The main objective of this study is to analyze the influence of principal leadership and virtual classroom-based supervision on the effectiveness of learning in elementary schools, with teachers' self-efficacy as a mediating variable. This research provides a deeper understanding of how the combination of effective leadership and technology-based supervision can improve the quality of learning. Thus, this research is not only theoretically important, but also has significant practical implications, especially in developing new strategies to improve learning effectiveness in primary schools. The results of this research are expected to be the basis for more innovative and adaptive education policies to technological developments and educational dynamics that continue to change.

RESEARCH METHOD

This study uses a survey method with a causality approach, which aims to determine the cause-and-effect relationship between the variables studied, namely principal leadership, virtual classroom-based supervision, teacher self-efficacy, and learning effectiveness. Causal research is used to determine the cause of one or more problems by analyzing correlational relationships or regressions between variables (Johnson & Reynolds, 2022; Ghasemi & Zahediasl, 2021; Meng et al., 2022).

This approach was chosen because it is in accordance with the purpose of the study which wants to test the direct and indirect influence between these variables (Wang et al., 2022; El-Bialy et al., 2023; Zhou & Zhou, 2021). A descriptive analytical approach is also used to elaborate findings in the form of research tools and statistical analysis aimed at testing the hypothesis proposed.

The sample in this study consisted of 200 elementary school teachers in primary school in Jakarta who were selected purposively based on certain criteria, such as a minimum of one year of service and involvement in a virtual classroom-based supervision program. The research location is in several elementary schools in Probolinggo Regency, East Java, especially in Krejengan District, Patemon Village. The number of samples used is in accordance with the guidelines provided by Hair et al. (2010), where the sample size in *Structural Equation Modeling (SEM)* ranges from 100 to 200 for *the maximum likelihood estimation (ML)* technique. The samples taken must be truly representative so that the results of the study can be generalized. Data collection was carried out using a questionnaire with a Likert scale of 1-5, where respondents were asked to provide responses to statements related to the research variables.

Table 2.1 Score Statement

Answer Choices	Score
Strongly disagree	1
Don't agree	2
Neutral	3
Agree	4
Strongly agree	5

For data analysis, this study uses the Structural Equation Modeling (SEM) technique with the help of AMOS 24 software. SEM was chosen because it is able to test the causality relationship between variables simultaneously and provide accurate estimates of the direct and indirect influence of the variables studied (Hoyle & Kenny, 2021; Lei & Wu, 2022; Mueller & Hancock, 2021). This analysis includes a model fit test (goodness of fit) to ensure that the model used is in accordance with the data obtained, as well as the Sobel test to test the significance of the mediation effect (Preacher et al., 2021; Hayes & Rockwood, 2022; Yung & Bentler, 2021). By using SEM, this study can provide a comprehensive overview of the influence of principal leadership and virtual classroom-based supervision on learning effectiveness, with teachers' self-efficacy as a mediating variable.

FINDINGS AND DISCUSSION

This section discusses the results of research obtained from data analysis using the Structural Equation Modeling (SEM) model with the help of AMOS 24 software. The discussion is divided into several sub-sections to make it easier for readers to understand the findings presented.

Description of Respondent Data

Before discussing the results of the study further, it is important to understand the characteristics of the respondents who are the subjects of this study. The respondents consisted of 200 teachers who taught in elementary schools.

The data collected includes their working period and age. Most respondents have a tenure of between 1 and 10 years, which reflects that the majority of teachers are teachers with relatively new teaching experience. On the other hand, the majority of respondents are in the age range of 30-40 years, which indicates they are in a productive phase in their career as teachers. This gives an indication that the results of the research will be very relevant for teachers who are still in the professional development stage.

Table 1. Respondents' Employment Period Data

Working Period (Years)	Number (n)	Percentage (%)
1-10	110	55%
11-20	77	39%
21-30	12	6%
31-40	1	1%
Total	200	100%

Table 1 shows the distribution of the working period of the respondents consisting of 200 teachers. Most respondents (55%) have had tenure between 1 to 10 years, which indicates that the majority of teachers are in the early to middle stages of their careers. As many as 39% of respondents have a working period of 11 to 20 years, indicating that almost half of the respondent population has significant teaching experience. Only 6% of respondents have worked between 21 and 30 years, and very few (1%) have worked for more than 30 years. Overall, this data depicts a teacher population dominated by those in the early to mid-stage stages of their teaching careers.

Table 2. Respondent Age Data

Age (Years)	Number (n)	Percentage (%)
20-25	25	13%
26-30	65	33%
30-40	88	44%
41-50	22	11%
Total	200	100%

Table 2 shows the age distribution of the 200 respondents who participated in this study. The majority of respondents were in the age range of 30 to 40 years, with a percentage of 44%, indicating that most teachers are in the middle stages of their careers. The 26- to 30-year-old age group is the second largest group, accounting for 33% of respondents, indicating that many teachers are still in the early stages of their careers. As many as 13% of respondents were in the age range of 20 to 25 years old, and only 11% were between the ages of 41 and 50 years old. This data indicates that the teacher population in this study is dominated by those who are relatively young and in a productive career phase.

Analisis Structural Equation Modeling (SEM)

In this section, we will review a research model that includes several variables and the relationships between them. The use of SEM allows us to understand the complex relationship between principal leadership, virtual classroom-based supervision, teacher self-efficacy, and learning effectiveness.

This analysis includes testing the model's compatibility with the data obtained to ensure that the research results are reliable and valid. The results of the analysis show that the model has a good fit level even though there are several areas that show moderate and marginal fit. Overall, however, this model is acceptable for explaining the relationships between the variables studied.
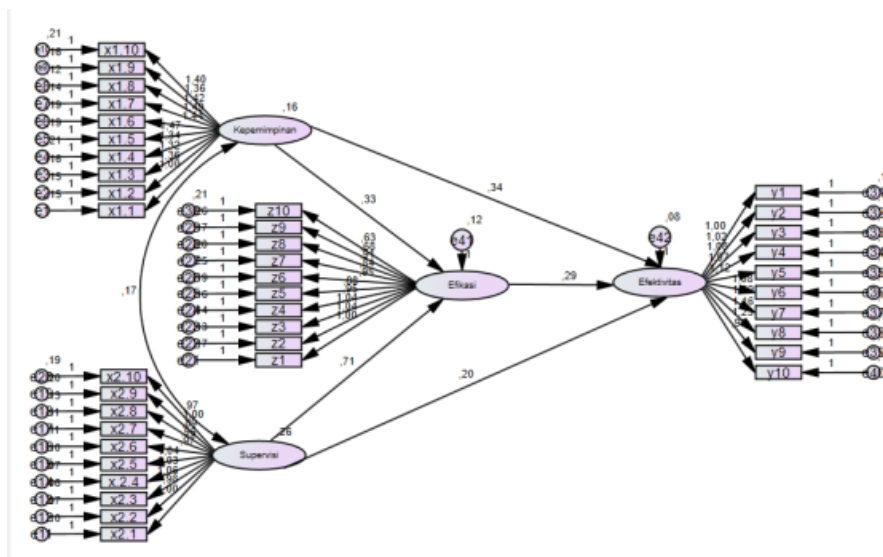

Figure 1. Goodness of Fit

The Structural Equation Modeling (SEM) path diagram shown illustrates the relationship between leadership, supervision, self-efficacy, and learning effectiveness in the context of education. The results of the analysis showed that leadership contributed significantly to teachers' self-efficacy with an estimated value of 0.16 and directly affected learning effectiveness with an estimate of 0.34. In addition, virtual classroom-based supervision also had a strong influence on self-efficacy with an estimate of 0.71, indicating that effective supervision can increase teachers' confidence in their abilities. Self-efficacy, in turn, affected learning effectiveness with an estimated value of 0.29, indicating that more confident teachers tended to create a more effective learning environment. Overall, this diagram emphasizes the importance of good leadership and supervision in improving teachers' self-efficacy, which then has a positive impact on learning effectiveness.

Tabel 3. Goodness of Fit Model

Goodness of Fit Index (GFI)	Cut-off Value	Results of Analysis	Model Evaluation
Chi-Square	0 (perfect fit)	1029.96	Moderate Fit
Probability	≥ 0.05	0.000	Moderate Fit
GFI	≥ 0.90	0.805	Moderate Fit
AGFI	≥ 0.90	0.764	Moderate Fit
RMSEA	≤ 0.05	0.51	Fit
TLI	≥ 0.90	0.952	Fit
NFI	≥ 0.90	0.887	Moderate Fit
CFI	≥ 0.90	0.958	Fit

From the table above, it can be seen that some indicators such as RMSEA and CFI show that this model is quite in line with the data obtained. Other indicators, such as GFI and AGFI, indicate that the model is in the medium fit category, which means that it is still acceptable but needs improvement in some areas to improve the fit of the model.

Hypothesis Testing

This section presents the results of hypothesis tests that show the direct and indirect influence of the variables studied. This test was carried out to determine whether these variables have a significant influence on the effectiveness of learning in elementary schools.

Direct Influence

The results of the direct influence test showed that all variables had a significant influence on the effectiveness of learning and teachers' self-efficacy. The principal's leadership and virtual classroom-based supervision both significantly affect teachers' self-efficacy. In addition, teachers' self-efficacy has also been proven to have a significant influence on learning effectiveness. This means that innovative principals and methods of supervision can increase teachers' confidence, which in turn improves the quality of learning. These findings show the importance of the role of leadership and technology in education.

Table 4. Direct Impact Test

Variable	Estimation	S. E	CR	P-Value	Conclusion
Self-Efficacy <-- Supervision	0.710	0.118	6.032	***	Significant
Self-Efficacy <-- Leadership	0.333	0.141	2.366	0.018	Significant
Effectiveness <-- Supervision	0.201	0.099	2.033	0.042	Significant
Effectiveness <-- Self-Efficacy	0.295	0.074	4.009	***	Significant
Effectiveness <-- Leadership	0.338	0.113	3.001	0.003	Significant

Table 4 displays the results of the direct influence test between the variables in this study, namely supervision, leadership, self-efficacy, and learning effectiveness. The results of the analysis showed that supervision had a very significant influence on teachers' self-efficacy, with an estimate of 0.710 and a CR of 6.032 ($p < 0.001$). In addition, leadership also showed a significant influence on self-efficacy with an estimate of 0.333 and CR 2.366 ($p = 0.018$). Furthermore, both supervision and leadership have a direct influence on learning effectiveness, with estimates of 0.201 ($p = 0.042$) and 0.338 ($p = 0.003$), respectively. Teachers' self-efficacy also significantly affected learning effectiveness with an estimate of 0.295 and CR 4.009 ($p < 0.001$). Overall, these findings indicate that both supervision and leadership play an important role in improving teachers' self-efficacy, which in turn has a positive impact on the effectiveness of learning in schools.

Indirect Influence (Mediation)

In addition to the direct influence, this study also explores the indirect influence of principal leadership and virtual classroom-based supervision on learning effectiveness through the mediation of teacher self-efficacy. The results of the Sobel test showed that teachers' self-efficacy was able to mediate the influence of the two independent variables significantly.

This suggests that to improve learning effectiveness, it is important to pay attention to how leadership and supervision affect teachers' confidence.

Table 5. Indirect Influence Test

Path of Influence				Sobel Test Scores	P-Value	Conclusion
Leadership Effectiveness	->	Self-Efficacy	->	3.323	0.000	Significantly, Mediation occurs
Supervision Effectiveness	->	Self-Efficacy	->	2.032	0.042	Significantly, Mediation occurs

Table 5 displays the results of the indirect influence test through the mediation of teachers' self-efficacy on learning effectiveness, using the Sobel test. The results of the analysis showed that the leadership path on the effectiveness of learning through self-efficacy showed a Sobel value of 3,323 with a p-value of 0.000, which means that this influence was significant and mediation occurred. The same thing also happened in the supervision pathway on the effectiveness of learning through self-efficacy, with a Sobel value of 2.032 and a p-value of 0.042, which also showed a significant influence and mediation. This means that teachers' self-efficacy plays an important role as a mediator that strengthens the influence of leadership and supervision on learning effectiveness. These results underscore the importance of improving teachers' self-efficacy as a strategy to improve and optimize the learning process in schools.

The Influence of Principal Leadership on Learning Effectiveness

The results of the study show that the leadership of school principals has a significant influence on the effectiveness of learning in elementary schools. With an estimate of 0.338, this influence is quite strong, showing that the ability of a school principal to lead and manage a school greatly determines the success of the learning process. Effective leadership involves not only administrative abilities but also skills in building positive relationships with faculty and students. This is in line with research conducted by Bush (2021) which found that effective school leadership can improve the quality of teaching and student learning outcomes through the development of a positive school culture and increased teacher motivation.

In addition, research from Leithwood et al. (2020) also supports these findings by confirming that principal leadership is one of the most important factors influencing students' academic success. Effective principals are able to create an environment conducive to learning, where teachers feel supported and motivated to deliver their best teaching. Thus, improvements in the principal's leadership style can have a direct impact on increasing learning effectiveness, which will ultimately improve student academic outcomes. Therefore, it is important for leadership training programs to focus on developing relevant leadership skills for school principals in order to achieve optimal learning outcomes.

The Effect of Virtual Classroom-Based Supervision on Learning Effectiveness

Virtual classroom-based supervision has also been proven to have a significant influence on learning effectiveness, with an estimate of 0.201. This shows that the use of technology in educational supervision can make a positive contribution to improving the quality of teaching in the classroom.

Supervision carried out through digital platforms allows school principals to provide feedback more quickly and specifically to teachers, which in turn can improve their performance in teaching. According to a study conducted by Ainscow and Sandill (2021), the use of technology in supervision can help overcome various obstacles often faced in traditional supervision, such as time and resource limitations.

In addition, research conducted by Spillane and Coldren (2020) also supports the importance of technology-based supervision, especially in the context of a global pandemic that forces schools to switch to remote learning methods. Virtual classroom-based supervision allows school principals to continue to monitor and support the learning process even though they are in sub-ideal conditions. This shows that adaptation to technology in supervision is not only relevant in the context of emergencies, but also as a long-term strategy to improve learning effectiveness. Thus, the development of technology-based supervision capabilities needs to be the focus of the training program for school principals and education supervisors.

The Effect of Teachers' Self-Efficacy on Learning Effectiveness

This study also found that teachers' self-efficacy had a significant influence on learning effectiveness, with an estimate of 0.295. Self-efficacy refers to a teacher's belief in his or her ability to teach and manage the classroom. Teachers who have high self-efficacy tend to be more confident in trying innovative teaching methods and are more effective in overcoming challenges that arise during the learning process. These findings are consistent with research conducted by Tschannen-Moran and Gareis (2021), which showed that teachers with high self-efficacy are more likely to use effective teaching strategies and are able to create a positive learning environment for students.

Furthermore, research from Zee and Koomen (2021) confirms that teachers' self-efficacy not only affects the quality of teaching, but also on the emotional well-being of teachers themselves. Teachers with high self-efficacy tend to have lower stress levels and are more satisfied with their jobs, which in turn has a positive impact on the quality of the teaching they provide. Therefore, improving teachers' self-efficacy through training programs and professional support is essential to ensure that they can provide high-quality teaching and create an effective learning environment. Support from school principals and education supervisors is needed to build and strengthen teachers' self-efficacy.

The Influence of Principal Leadership on Teachers' Self-Efficacy

The leadership of the principal also has a significant influence on the self-efficacy of teachers, with an estimate of 0.333. Principals who are able to create a positive and supportive work environment can increase teachers' confidence in their own abilities. Supportive leadership, which involves providing constructive feedback and a drive for innovation, can strengthen teachers' self-efficacy. This finding is supported by research conducted by Day et al. (2020), which found that transformational leadership from school principals can increase teachers' self-efficacy, especially in facing changes and challenges in the world of education.

On the other hand, research by Liu and Hallinger (2021) emphasizes that school principals who are proactive in providing training and professional development to teachers can help improve their self-efficacy.

Teachers who feel supported by their principals tend to be more confident and better prepared to face various challenges in teaching. Therefore, principals must continue to work to create a supportive and empowering environment for teachers to ensure that they have high confidence in carrying out their duties. Thus, high teacher self-efficacy will have a positive impact on the quality of teaching and student learning outcomes.

The Effect of Virtual Classroom-Based Supervision on Teachers' Self-Efficacy

Virtual classroom-based supervision also showed a significant influence on teachers' self-efficacy, with an estimate of 0.710. The use of technology in supervision provides an opportunity for teachers to receive more direct and relevant feedback, which can increase their confidence in their teaching abilities. Supervision carried out with this approach allows teachers to continue to develop and learn from the feedback provided more effectively. Research conducted by Darling-Hammond et al. (2020) shows that technology-based supervision can have a greater positive impact on teachers' professional development compared to traditional supervision methods.

Other research by Kraft and Blazar (2020) also supports these findings, emphasizing that digitally conducted supervision allows teachers to be more responsive to feedback and faster in implementing improvements in their teaching. This shows that the integration of technology in supervision not only helps improve teachers' performance but also strengthens their confidence in teaching ability. As such, it is important for schools to continue to develop and implement technology-based supervision methods to ensure that teachers get the support they need to develop and improve their self-efficacy.

Self-Efficacy as a Mediation Variable

Teachers' self-efficacy was found to be a significant mediating variable between the principal's leadership and virtual classroom-based supervision on learning effectiveness. With a Sobel test score of 3,323 for the leadership pathway and 2,032 for the supervision pathway, this result shows that teachers' self-efficacy plays an important role in bridging the influence of leadership and supervision on learning effectiveness. Teachers' high self-efficacy allows them to be better at implementing directions from leadership and supervision, which ultimately increases the effectiveness of learning. Research conducted by Collie et al. (2021) supports these findings by showing that teachers' self-efficacy is an important mediator that links structural support from schools to student learning outcomes.

In addition, research by Skaalvik and Skaalvik (2020) also found that teachers' self-efficacy can improve their performance in teaching, especially in situations that demand adaptation and innovation. In other words, teachers who have high self-efficacy are better able to implement changes and improvements in their teaching, which is triggered by supportive leadership and effective supervision. Therefore, the strategy to increase learning effectiveness in schools needs to pay attention to strengthening teachers' self-efficacy as one of the key components. By strengthening teachers' self-efficacy, schools can ensure that the positive influence of leadership and supervision is truly reflected in the improvement of student learning outcomes.

This study makes an important contribution to education management by showing that principal leadership and virtual classroom-based supervision significantly improve learning effectiveness through improving teachers' self-efficacy. Using the *Structural Equation Modeling (SEM)* model, this study confirms that effective leadership not only influences strategic decisions, but also creates an environment that supports teachers' professional development, which in turn has a positive impact on the quality of learning. In addition, the introduction of technology-based supervision as a modern management tool shows great potential in addressing the challenges of distance learning and ensuring teachers remain motivated and competent in the face of current educational dynamics.

CONCLUSION

This study highlights the importance of the leadership role of school principals and virtual classroom-based supervision in increasing learning effectiveness through increasing teachers' self-efficacy in Jakarta. These findings confirm that effective leadership is not only limited to strategic decision-making, but also plays a crucial role in creating an environment that supports teachers' professional development. In this context, technology-based supervision has emerged as a highly relevant tool, especially in the face of the challenges of distance learning, ensuring teachers remain motivated and able to adapt to the evolving dynamics of education. These findings provide new insights and reinforce the understanding that the combination of supportive leadership and the use of technology in supervision can significantly improve the quality of learning in primary schools.

The main strength of this research lies in its contribution to renewing the perspective of education management by integrating technological approaches in education supervision. This study successfully proposes a new method that is relevant in the context of modern education and highlights the importance of self-efficacy variables as mediators in the relationship between leadership and learning effectiveness. However, this study has limitations in terms of its limited scope to one type of educational institution and may not cover broader variations such as gender differences or teacher ages. Therefore, further research is needed to broaden the scope of the analysis, including different demographics and conditions, in order to obtain a more comprehensive understanding. This research provides a solid basis for the development of more effective education policies, by emphasizing the importance of technological adaptation and teachers' professional development in achieving optimal educational outcomes.

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