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The Influence of Instructional Leadership and Teacher Digital Literacy on the Quality of In-Depth Learning in Public Elementary Schools

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ABSTRACT

Purpose: The purpose of this study is to: determine the magnitude of the influence of instructional leadership and teachers' digital literacy together on the quality of in-depth learning. **Methods**: The research approach used is quantitative. This type of research uses correlation research. The population of this study was 244 teachers and the research sample was 152 teachers. Data collection was carried out using a questionnaire. The data analysis techniques used in this study were descriptive data analysis, prerequisite tests including normality tests, multicollinearity tests, heteroscedasticity tests, linearity tests and hypothesis tests including simple and multiple linear regression. **Findings**: The results of the study showed that: (1) the correlation of instructional leadership on the quality of in-depth learning was 0.824. The influence of instructional leadership had a significant effect on the variable of the quality of in-depth learning by 78.0%. (2) The correlation of teachers' digital literacy on the quality of in-depth learning was 0.960. The influence of teacher digital literacy has a significant effect on the variable of in-depth learning quality by 92.1%. (3) Then the correlation coefficient value r is 0.963. The result of the coefficient of determination of the influence of variables X1 and X2 on Y is 92.7%. **Research implications**: This study suggests that optimizing principals' instructional leadership and enhancing teachers' digital literacy can improve the quality of in-depth learning. **Originality**: This research uniquely examines the combined role of instructional leadership and teachers' digital literacy in influencing in-depth learning quality at the elementary school level, a topic rarely explored.

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INTRODUCTION

Education is a systematic effort to improve the quality of learning that takes place in schools, particularly in the classroom, as part of achieving national education goals. Teachers play a central role in creating a conducive, inspiring, and student-centered learning environment, enabling students to actively participate in seeking information, solving problems, thinking critically, and effectively expressing their ideas. A quality learning process requires synergistic collaboration between teachers and students, so that educational goals can be achieved optimally and sustainably. To achieve high-quality education, it is necessary to organize and improve the quality of classroom learning as a first step towards quality education.

The quality of learning plays a strategic role in ensuring the achievement of national education goals, which emphasize the development of students' knowledge, skills, and character. At the elementary school level, learning is not merely the delivery of material but also a crucial foundation for students' holistic development, encompassing cognitive, affective, and psychomotor aspects. Effective learning is designed to be meaningful, contextual, and student-centered, and fosters active participation, collaboration, critical thinking, and the ability to apply knowledge in real life. Therefore, learning quality is a crucial aspect that requires serious attention in efforts to improve the quality of education in elementary schools (Hastuti 2024).

Various recent education policies in Indonesia also reinforce the direction of improving learning quality. The government, through Ministerial Regulation of Education, Culture, Research, and Technology Number 12 of 2024 concerning the Curriculum for Elementary and Secondary Education, provides a legal framework for the implementation of the Independent Curriculum, which aims to improve the quality of education equitably. This policy encourages learning that is more flexible, contextual, and relevant to the needs of students in the global era.

Furthermore, Ministerial Regulation of Elementary and Secondary Education Number 13 of 2025 emphasizes the importance of an in-depth learning approach to foster holistic, strategic understanding and contextual application of concepts in the classroom. This policy also serves as the basis for learning management in schools implementing both the 2013 Curriculum and the Independent Curriculum. The government is also implementing a learning digitalization program to accelerate the equitable distribution of education quality through more widespread learning technology across Indonesia.

The quality of learning is a key indicator of the success of elementary school education. Learning quality is not solely defined as academic achievement, but also encompasses active student engagement, critical thinking skills, collaboration, and the ability to apply knowledge in real-life contexts (Suryadi 2024). Quality learning can encourage students to develop holistically, across cognitive, affective, and psychomotor domains, thus contributing to the optimal development of their potential and character (Daryanto 2023).

The success of implementing quality learning is greatly influenced by the school's readiness to translate policies into classroom practice, which includes school leadership, teacher pedagogical competence, and the effective use of learning technology. Several studies have shown that in-depth learning requires strong instructional leadership and adequate teacher pedagogical literacy so that learning does not stop at delivering material but fosters conceptual understanding, reflection, and contextual application of knowledge (Hattie 2019). Therefore, the gap between education policy and learning practices in schools is a crucial issue that requires further study, particularly at the elementary school level, which serves as the primary foundation of formal education.

An evaluation by the School Supervisor in Kaliwungu District, Kendal Regency, revealed that first, more than 60% of teacher-developed lesson plans were not oriented toward in-depth learning, characterized by learning objectives that focused on lower-level cognitive outcomes and a lack of integration of critical thinking, creativity, collaboration, and communication skills. Second, learning implementation tended to be teacher-centered, resulting in low student engagement and insufficient space for exploration, discussion, and contextual problem-solving. Third, more than 50% of teachers had not optimally utilized learning media and technology due to limited digital literacy and a lack of variety in the use of digital-based learning resources. Fourth, Teachers have not yet referred to Indonesian pedagogical concepts and are not in-depth learning using AI and have not used less varied and innovative learning strategies, so that learning is still dominated by lecture and assignment methods, which have an impact on low student motivation and interest in learning.

Furthermore, the report card for elementary schools in Kaliwungu District, Kendal Regency, indicated that the quality of learning was moderate. This is known based on the recapitulation results for each school, as follows:

Table 1. Learning Quality at Kaliwungu District Elementary Schools in Kendal

Nu	Indicator	Achievement Value in 2024	Achievement Value in 2025	Change in achievement value
1	Learning Quality	78,45	74,32	Down 4,13
2	Classroom Management	80,12	76,05	Down 4,07
3	Psychological Support	76,38	71,90	Down 4,48
4	Learning Methods	79,06	73,84	Down 5,52

Based on Table 1, the quality of learning at public elementary schools in Kaliwungu District, Kendal Regency, shows a decline in achievement across all indicators. The overall learning quality indicator decreased by 4.13 points, from 78.45 in 2024 to 74.32 in 2025. The classroom management indicator decreased by 4.07 points. The psychological support indicator decreased by 4.48 points. The most significant decline occurred in the learning methods indicator, which decreased by 5.52 points. Given these results, leadership styles from principals are needed to foster and provide direction to improve learning quality. One factor that can influence learning quality is instructional leadership.

The principal's instructional leadership is a factor that can influence learning quality. The principal's role in implementing instructional leadership is crucial for improving teacher learning skills and the quality of learning in schools. In line with (Anis 2022) statement, he explained that the success of education and learning in schools is influenced, among other things, by the principal's ability to manage various components within the school. The success of education and learning in schools depends heavily on the principal's ability to manage all existing elements, including teachers, students, curriculum, and facilities.

The Directorate of Education Personnel, Ministry of National Education (2022) explains that instructional leadership is leadership that focuses on/emphasizes learning, whose components include the curriculum, teaching and learning process, assessment (assessment of learning outcomes), teacher evaluation and development, excellent service in learning, and building a learning community within the school. Instructional leadership focuses on creating conditions that support effective learning through curriculum development, learning supervision, and teacher

empowerment. Instructional leadership encompasses all actions taken by the principal, or delegated to others, to encourage growth in student learning (Mestry 2018).

Based on the guidance of the Elementary School Supervisor in Kaliwungu District, Kendal Regency, it was stated that more than 50% of school principals have not involved all school members in setting school goals. Then, more than 60% of principals have not managed and developed the curriculum. Then, only 50% of principals provide mentoring and educate teachers in improving classroom learning. Then the results of the elementary school education report in Kaliwungu District, Kendal Regency show that the instructional leadership of school principals is still low. Of the 23 elementary schools analyzed, there are schools that experienced an increase in the achievement score of instructional leadership with different variations in the increase. The most significant increase occurred at SDN 2 Sarirejo, which experienced an increase of 4.83 points, from 62.86 in 2024 to 67.69 in 2025. This increase indicates a strengthening of the role of the principal in the aspects of learning planning, academic supervision, and continuous teacher mentoring. Furthermore, several other schools, such as SDN 1 Kutoharjo, SDN 3 Sumberejo, and SDN 1 Mororejo, also showed increases in their scores, albeit at a more moderate level.

However, the majority of schools in the table showed a decline in their instructional leadership achievement scores by 2025. This decline varied, ranging from a slight decline, such as at SDN 2 Sumberejo (0.85 points), to a significant decline, such as at SDN 3 Sarirejo (4.13 points). This situation indicates that the implementation of instructional leadership in a number of schools still faces obstacles, including limited time for principals to supervise learning, less than optimal monitoring of the teaching and learning process, and inconsistent follow-up on supervision results.

Instructional leadership has a significant impact on improving the quality of learning. This leadership helps teachers develop more effective teaching methods and encourages them to continuously improve their professional skills (Leithwood 2020). (Ryan 2020) emphasizes that effective leadership encourages teachers to be more creative, innovative, and committed in implementing learning. (Raihani 2020) research states that instructional leadership can improve learning quality by up to 30%. (Pratiwi 2021) research also shows a positive correlation between instructional leadership and learning quality.

In addition to instructional leadership, teachers' digital literacy is also a crucial factor in improving the quality of in-depth learning. Digital literacy encompasses the ability to critically and responsibly understand, use, evaluate, and produce information through digital technology (Haryono. 2020). Teachers with good digital literacy are able to utilize technology to create more engaging, interactive, and relevant learning experiences tailored to students' needs (Suhendra 2020). Research by (Zawacki-Richter 2023) shows that teachers' digital literacy has a positive and significant relationship with learning quality. Digitally literate teachers are able to create engaging and interactive learning media, such as instructional videos, digital presentations, or simulations, which can enhance student interest and understanding (Yuliana 2018).

Digital literacy enables teachers to access a wider range of learning resources, develop innovative learning media, and implement technology-based collaborative learning. However, the reality at one public elementary school in Kaliwungu District, Kendal Regency, shows that teachers still have limitations in operating learning technology devices, such as computers, LCD projectors, and digital learning applications. This situation means that the use of technology in learning has not been systematically integrated and remains incidental. Furthermore, not all teachers are able to utilize digital platforms as learning resources, such as Learning Management Systems (LMS), online learning applications, and open educational resources. Some teachers still rely on printed textbooks and lecture methods, resulting in less varied learning and not fully encouraging in-depth learning that requires active involvement and critical thinking skills in students. Improving teachers' digital literacy skills is a crucial investment in improving the overall quality of learning. Educational institutions need to provide support in the form of adequate training, resources, and facilities to help teachers develop digital competencies.

Research on the influence of instructional leadership and teacher digital literacy on the quality of in-depth learning is highly urgent, both theoretically and empirically, practically, and in education policy. Theoretically, this research is important because studies on in-depth learning at the elementary school level are still limited and generally conducted partially, so they do not provide a complete picture of the relationship between the principal's instructional leadership and teachers' digital literacy in improving the quality of in-depth learning.

Empirically, pre-research observations indicate that the implementation of immersive learning at a public elementary school in Kaliwungu District has not been optimal, as evidenced by students' low conceptual understanding and learning outcomes that remain below the minimum mastery standard. This situation indicates a gap between the ideal concept of immersive learning and actual learning practices. Therefore, this study is crucial to objectively reveal the extent to which principals' instructional leadership and teachers' digital literacy influence the quality of immersive learning, thereby identifying factors that hinder and support successful learning.

METHOD

This research is quantitative and has a correlational design. The location of the analysis is the Kaliwungu District Public Elementary School in Kendal. The population analyzed was 244 respondents who were teachers, and the sample was determined using the Slovin's method is as follows:

$$\mathbf{n} = \frac{N}{1+Ne^2} \qquad (1)$$

Where:
n : Number of samples
N : Population
e : Tolerance limit of error

This sampling was conducted at a 95% confidence level or a 5% critical value, so the sample size can be calculated as follows:

$$= \frac{244}{(1 + (244x0{,}05^2))}$$

n = 151.55 rounded to 152 teachers
n = 152
Therefore, the sample size taken using the proportional random sampling technique was 152 teachers.

Data were collected through a questionnaire with a Likert scale. The questionnaire consisted of three instruments: an in-depth learning quality questionnaire with dimensions of 1) classroom management, 2) learning methods/strategies, 3) psychological support, 4) appropriateness and relevance of learning, and 5) quality and effectiveness of learning. The Instructional Leadership Questionnaire with dimensions of 1) setting school goals, 2) managing the curriculum of educational units, and 3) supporting teacher reflection. The teacher digital literacy questionnaire covers the following dimensions: 1) digital technology mastery (ICT Literacy), 2) information literacy, 3) critical and evaluative thinking, 4) digital creativity, and 5) digital pedagogical competence. The instructional leadership variable contains 32 statements, the teacher digital literacy variable contains 45 statements, and the learning quality variable contains 54 statements. The instrument was tested for validity and reliability, revealing findings for the instructional leadership variable containing 29 statements, the teacher digital literacy variable containing 39 statements, and the learning quality variable containing 49 statements.

After it was said that there was reliability and validity in the data, then the prerequisites were tested consisting of normality testing showing that the instructional leadership data, teacher digital literacy and the quality of in-depth learning were normally distributed, multicollinearity testing showing that the instructional leadership and teacher digital literacy variables did not have multicollinearity, linearity testing showing that the data on the teacher digital literacy variables and the quality of in-depth learning had a linear equation/relationship, heteroscedasticity testing showing that the results did not show symptoms of heteroscedasticity, the regression model used was suitable for research. Then the hypothesis test included structural testing, F testing and T testing. The author processed the analysis findings data through SPSS 25 software.

RESULTS AND DISCUSSION

1. The Influence of Instructional Leadership on the Quality of Deep Learning in Public Elementary Schools in Kaliwungu District

The findings of the analysis of instructional leadership variables on the quality of deep learning are explained in this table:

Table 2. Correlation of Instructional Leadership with the Quality of Deep Learning

		Instructional Leadership	Quality of Deep Learning
Instructional Leadership	Pearson Correlation	1	.824**
	Sig. (2-tailed)		.000
	N	152	152
Quality of Deep Learning	Pearson Correlation	.824**	
	Sig. (2-tailed)	.000	
	N	152	152

The correlation analysis findings of instructional leadership on the quality of in-depth learning showed a positive value, with an r-count of 0.824. Meanwhile, a one-tailed sig. of 0.000 proves a one-way correlation between X1 and Y, which is significant because this value is below 5%, or 0.000 < 0.05. Furthermore, the findings of a simple regression analysis prove the correlation model of instructional leadership on the quality of in-depth learning presented in the equation $\hat{Y} = 3.474 + 1.724X1$. The partial t-test findings show a significance probability value of 0.000 < 0.05, meaning the independent variable is a significant explanatory component of the dependent variable, with a t-count value > t-table (17.843 > 1.655076), indicating that instructional leadership partially significantly influences the quality of in-depth learning.

Table 3. Summary Test of Instructional Leadership Variables on the Quality of In-depth Learning

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.824[a]	.780	.778	9.058

The R-square value is 0.780, indicating a 78.0% influence of instructional leadership (X1) on the quality of in-depth learning (Y), indicating a strong influence on learning quality (Y). The r-count value of 0.824 indicates that instructional leadership (X1) strongly influences the quality of in-depth learning (Y).

The findings of this study align with research by (Suratmin 2025), which showed that instructional leadership influences learning quality by 45.50%. The regression equation was Y = 44.388 + 0.756X1 and a correlation coefficient of 0.455, indicating a 45.50% influence of instructional leadership on learning quality. Furthermore, research conducted by (Werdiningsih 2022) showed that the principal's instructional leadership and professional competence influenced teacher performance by 78.4%. Principals who are directly involved in learning, provide feedback to teachers, and set clear academic expectations have been shown to improve learning quality.

Deep learning emphasizes active student involvement, the development of critical thinking, reflection, and problem-solving skills (Muvid 2024). Effective instructional leadership will encourage teachers to design student-centered learning, integrate reflection, and emphasize in-depth conceptual understanding (Dewi 2021). Therefore, instructional leadership is an essential prerequisite for implementing deep learning in elementary schools.

The results of this study are relevant to policies aimed at improving the quality of learning, which emphasize the role of principals as learning leaders. Principals are not only required to be managers but also instructional leaders capable of directing, coaching, and inspiring teachers to implement quality, student-centered learning. The practical implication of this study is the need to strengthen principals' instructional leadership competencies through ongoing training, mentoring, and supervision. With strong instructional leadership, elementary schools will be better prepared to implement in-depth learning that fosters higher-order thinking skills and student character.

The results of this study confirm that instructional leadership is a strategic factor in improving the quality of in-depth learning. Principals who consistently carry out their instructional leadership role will have a significant positive impact on the quality of learning, while supporting the achievement of educational goals holistically.

2. The Influence of Teacher Digital Literacy on the Quality of In-depth Learning in Public Elementary Schools in Kaliwungu District, Kendal

The findings of the analysis of the variable of teacher digital literacy on the quality of in-depth learning are presented in this table:

Table 4. Correlation of Teacher Digital Literacy on the Quality of In-depth Learning

		Teacher Digital Literacy	Quality of Deep Learning
Teacher Digital Literacy	Pearson Correlation	1	.960**
	Sig. (2-tailed)		.000
	N	152	152
Quality of Deep Learning	Pearson Correlation	.960**	
	Sig. (2-tailed)	.000	
	N	152	152

The correlation analysis findings on the teacher digital literacy variable with the quality of in-depth learning were positive, with a calculated r of 0.960. The simple regression analysis findings proved that the model of teacher digital literacy on the quality of in-depth learning is called the equation $\hat{Y} = 10.637 + 1.358X2$. The partial t-test findings proved a significant probability value of 0.000 < 0.05, meaning the independent variable is a significant explanatory factor for the dependent variable, with a calculated t value > t table (41.961 > 1.655076), meaning that the teacher digital literacy variable partially has a significant influence on the quality of in-depth learning.

Table 5. Summary Test of Teacher Digital Literacy on the Quality of In-depth Learning

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.960[a]	.921	.921	4.485

The R-square value is 0.921, indicating a strong influence between teacher digital literacy (X2) and the quality of in-depth learning (Y). A 92.1% correlation coefficient of r is 0.960, indicating a strong influence between teacher digital literacy and the quality of in-depth learning.

This research finding aligns with research by (Sukardi 2023) that found digital literacy had a positive and significant influence on learning quality, while technological tools had a positive and significant influence on learning quality. Previous research by (Hatlevik 2018) also showed that teacher digital literacy significantly impacted teaching quality and student engagement. Teachers with high digital literacy tend to be able to create interactive and cognitively challenging learning environments, which are key characteristics of in-depth learning.

This finding is relevant to the demands of educational transformation in the digital era. Teachers are expected to utilize technology not only as a tool but as an integral part of learning strategies. Teacher digital literacy is a crucial prerequisite for implementing technology-based learning oriented toward competency development. The practical implications of this research are the need to improve teachers' digital literacy through ongoing training, teacher learning communities, and policy support from the education office. Efforts to improve teachers' digital literacy will have a direct impact on improving the quality of in-depth learning, particularly in creating innovative, contextual, and learner-centered learning.

This research confirms that teachers' digital literacy is a key factor in improving the quality of in-depth learning in elementary schools. Teachers with high digital literacy will be able to facilitate more meaningful, reflective, and understanding-oriented learning, thus optimally supporting the achievement of educational goals. While all analyses and tests related to the regression calculations of teachers' digital literacy on the quality of in-depth learning above yielded positive results, there were some data deviations from the sample studied.

Deep learning emphasizes active student engagement, conceptual understanding, and critical, collaborative, and reflective thinking skills (Mustaghfirin 2025). Teacher digital literacy enables deep learning through the use of digital technology as a means of exploration, collaboration, and reflection. Digitally literate teachers are able to select and use technology appropriately to support meaningful learning objectives.

In theory, when teachers' digital literacy is strong, the quality of deep learning will also be good. However, several samples studied deviated from this theory. This indicates that learning quality is not solely influenced by teachers' digital literacy but also by several other factors. This means that teachers' digital literacy is not the sole factor influencing the quality of deep learning.

Positive teacher digital literacy is a key foundation for improving the quality of deep learning. Strong and supportive teacher digital literacy motivates teachers to improve the quality of learning. Therefore, educational institutions need to create and maintain teacher digital literacy that supports the improvement of the quality of deep learning.

3. The Influence of Instructional Leadership and Teacher Digital Literacy on the Quality of Deep Learning at Public Elementary Schools in Kaliwungu District, Kendal

The findings from the analysis of the variables influencing instructional leadership and teacher digital literacy on the quality of deep learning are presented in the following table:

Table 6. Correlation Coefficient of the Influence of Instructional Leadership and Teacher Digital Literacy on the Quality of Deep Learning

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.748	3.926		4.266	.000
	Instructional Leadership	.273	.079	.131	3.445	.000
	Teacher Digital Literacy	1.208	.054	.854	22.523	.000

The findings of the multiple regression analysis prove that the relationship model between instructional leadership and teacher digital literacy on learning quality is expressed by the equation $\hat{Y} = 16.748 + 0.273\ X1 + 1.208\ X2$. The findings of the Partial t-test are based on the calculated t value of X1 against Y, which is 3.445 while the t-table is 1.655076. This means that t-count > t-table (3.445 > 1.655076), so the instructional leadership variable partially

has a significant influence on the quality of in-depth learning. The calculated t value of X2 against Y is 22.523 while the t-table is 1.655076. This means that t-count > t-table (22.523 > 1.655076), meaning the teacher digital literacy variable partially has a significant influence on the quality of in-depth learning.

Table 7. Summary Test of Instructional Leadership and Teacher Digital Literacy on the Quality of In-depth Learning

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.963[a]	.927	.926	4.331

The R-square value of 0.927 proves that the variation in the quality of in-depth learning (Y) can be explained simultan3ously by the variables of instructional leadership (X1) and teacher digital literacy (X2), amounting to 92.7%, indicating a strong coefficient of determination. Furthermore, the correlation coefficient of r is 0.963, indicating that instructional leadership and teacher digital literacy have a strong influence on the quality of in-depth learning.

Instructional leadership positions the principal as the primary actor in improving the quality of learning through setting clear academic goals, monitoring learning, and developing teacher professionalism (Dwiyono 2022). According to (Hasanah 2023), effective instructional leadership creates a school climate that encourages teachers to continuously improve the quality of learning, including through the use of digital technology.

Teacher digital literacy plays a crucial role in supporting in-depth learning, which emphasizes active engagement, collaboration, and problem-solving. In-depth learning, as stated by (Dalyono 2021), requires a learning environment that allows students to explore knowledge critically and reflectively. Instructional leadership provides direction and structural support, while teachers' digital literacy is the primary means of implementing immersive learning strategies in the classroom. Thus, these two variables have a mutually reinforcing relationship.

The findings of this study align with those of (Suseno 2022) who found that instructional leadership influences learning quality by 45.50%. The regression equation Y = 44.388 + 0.756X1 and a correlation coefficient of 0.455 indicated a 45.50% effect of instructional leadership on learning quality. Furthermore, research conducted by (Naqyrizkiani 2022) showed that principal instructional leadership and professional competence influenced teacher performance by 78.4%. (Nani 2022) found that digital literacy had a positive and significant effect on learning quality, while technological tools had a positive and significant effect on learning quality.

The results of this study are relevant to efforts to transform learning in the digital era. Principals are required to consistently carry out instructional leadership roles, while teachers need to continuously develop digital literacy to be able to design contextual and competency-oriented learning. The results of this study confirm that improving the quality of immersive learning requires a comprehensive approach through strengthening the instructional leadership of principals and the continuous development of teachers' digital literacy. The synergy of these two factors is key to creating meaningful, effective, and student-centered learning in elementary schools.

Based on the above results, strong instructional leadership from principals and strong teacher digital literacy are needed to improve the quality of immersive learning. Principals and teachers are key determinants of educational outcomes. The success of educational delivery is largely determined by the readiness of principals and teachers to prepare themselves and demonstrate strong performance to produce high-achieving students. A commitment from each principal and teacher is essential to improving the quality of immersive learning to achieve maximum performance. With strong teacher competency, performance, and digital literacy, supported by strong instructional leadership, principals are expected to improve the quality of immersive learning.

CONCLUSION

There is a positive and significant influence of instructional leadership on the quality of in-depth learning indicated by the results of the regression equation calculation $\hat{Y}$ = 3.474 + 1.724 X1. Then the r-count value is 0.824 with a very strong category and the t-count value> t-table (17.843> 1.655076). Then based on the R-square value of the instructional leadership variable (X1) on the quality of in-depth learning (Y) has a strong category influence of 78.0%. There is a positive and significant influence of teacher digital literacy on the quality of in-depth learning indicated by the results of the regression equation calculation $\hat{Y}$ = 10.637 + 1.358X2. Then the r-count value is 0.960 with a strong category and the t-count value> t-table (41.961> 1.655076). Then based on the R-square value of the teacher digital literacy variable (X2) on the quality of in-depth learning (Y) has a strong category influence of 92.1%. There is a significant influence of instructional leadership and teacher digital literacy on the quality of in-depth learning as shown by the results of the regression equation calculation $\hat{Y}$ = 16.748 + 0.273 X1 + 1.208 X2. Then the correlation coefficient value r is 0.963 with a very strong category. The results of the coefficient of determination of the influence of the instructional leadership and teacher digital literacy variables on the quality of in-depth learning (Y) are 92.7% in the strong category.

The research results show that instructional leadership and teacher digital literacy both have a positive, significant, and strong influence on the quality of immersive learning. Partially, teacher digital literacy contributes more than instructional leadership, confirming that in the modern learning context, teachers' ability to utilize digital technology is a key factor in creating meaningful, interactive learning that is oriented toward students' deep understanding. However, when both variables are tested simultaneously, their contribution is very strong, indicating a synergy between the principal's instructional leadership as a guide and reinforcer of academic culture, and teacher digital literacy as an operational instrument in implementing classroom learning. Thus, the success of immersive learning is determined not only by individual teacher competency but also by the support of an effective leadership system.

Based on these findings, principals need to strengthen their role as instructional leaders through ongoing academic supervision, teacher mentoring, and developing a learning vision integrated with the curriculum. Teachers also need to be facilitated in improving their digital literacy through training, workshops, and professional learning communities focused on the use of learning technology. Furthermore, schools need to integrate policies that support both aspects, build an innovative learning culture, and conduct regular data-based monitoring and evaluation. However, this study has limitations, including a scope limited to one sub-district, the variables studied are still limited, the use of a quantitative approach that has not been able to explore the process in depth, and the potential bias of the self-report instrument, so that the results of this study need to be interpreted carefully and can be developed further in subsequent research.

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AUTHOR CONTRIBUTION STATEMENT

NI was responsible for the research design, data collection and analysis, and manuscript writing. WK contributed to the development of research instruments, data analysis, and manuscript revision. NAM played a role in the development of the research concept, supervision of the overall research process, and final revision of the manuscript.

AI DISCLOSURE STATEMENT

The authors declare that this research was conceived, researched, written, and edited without the aid of artificial intelligence (AI) techniques.

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