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# The Effect of Digital Literacy and Educational Infrastructure on Educational Quality through Digital Learning Effectiveness in Public Elementary Schools in Serang Regency

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## ABSTRACT

Digital transformation in education requires teachers to possess strong digital literacy and adequate educational facilities and infrastructure to support effective digital learning. However, the quality of education in public elementary schools in Serang Regency continues to face several challenges, including the limited integration of technology into classroom instruction, inadequate educational facilities and infrastructure, and the low effectiveness of digital learning. This study aims to analyze the effects of digital literacy and educational facilities and infrastructure on educational quality, both directly and indirectly through digital learning effectiveness as a mediating variable in public elementary schools in Serang Regency. This study employed a quantitative approach using an explanatory survey design. The study involved 264 teachers from public elementary schools in Serang Regency. Data were collected using a Likert-scale questionnaire and analyzed using Structural Equation Modeling–Partial Least Squares (SEM-PLS) to examine the direct and indirect relationships among the variables. The findings indicate that digital literacy and educational facilities and infrastructure have positive and significant effects on educational quality, both directly and indirectly through digital learning effectiveness as a mediating variable. In conclusion, improving teachers' digital literacy, supported by adequate educational facilities and infrastructure and effective digital learning, plays an important role in enhancing the quality of education in public elementary schools in Serang Regency. These findings provide valuable insights for policymakers and schools in formulating strategies to improve educational quality through digital transformation.

**Article Information**

***Kata Kunci:***
*Literasi Digital; Sarana Prasarana; Efektivitas Pembelajaran Digital; Mutu Pendidikan; Sekolah Dasar Negeri Kabupaten Serang*

## ABSTRACT

Transformasi digital dalam pendidikan menuntut peningkatan literasi digital guru serta ketersediaan sarana prasarana yang memadai untuk mendukung pembelajaran digital yang efektif. Namun, mutu pendidikan di Sekolah Dasar Negeri Kabupaten Serang masih menghadapi tantangan berupa belum optimalnya pemanfaatan teknologi, keterbatasan sarana prasarana, dan rendahnya efektivitas pembelajaran digital. Penelitian ini bertujuan menganalisis pengaruh literasi digital dan sarana prasarana terhadap mutu pendidikan, baik secara langsung maupun tidak langsung melalui efektivitas pembelajaran digital pada Sekolah Dasar Negeri Kabupaten Serang. Penelitian menggunakan pendekatan kuantitatif dengan desain survei eksplanatori. Populasi penelitian adalah guru Sekolah Dasar Negeri di Kabupaten Serang dengan sampel sebanyak 264 responden. Data dikumpulkan menggunakan kuesioner berskala Likert dan dianalisis menggunakan Structural Equation Modeling-Partial Least Squares (SEM-PLS) untuk menguji hubungan langsung dan tidak langsung antarvariabel. Hasil penelitian menunjukkan bahwa literasi digital dan sarana prasarana berpengaruh positif dan signifikan terhadap mutu pendidikan, baik secara langsung maupun melalui efektivitas pembelajaran digital sebagai variabel mediasi. Penelitian ini menyimpulkan bahwa peningkatan literasi digital guru, didukung oleh sarana prasarana yang memadai dan pembelajaran digital yang efektif, berperan penting dalam meningkatkan mutu pendidikan di Sekolah Dasar Negeri Kabupaten Serang. Hasil penelitian ini diharapkan menjadi dasar bagi pemerintah daerah, dinas pendidikan, dan sekolah dalam merumuskan kebijakan peningkatan mutu pendidikan berbasis transformasi digital.

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## 1. INTRODUCTION

Digital transformation has become an important consideration in improving educational processes and outcomes. In schools, the integration of digital technology requires more than access to technological devices; it also depends on teachers' ability to use digital resources appropriately and the availability of infrastructure that supports meaningful learning activities. Digital literacy, educational infrastructure, and digital learning effectiveness are therefore interrelated dimensions of technology-supported education. However, their contributions to educational quality may differ depending on how digital competencies and resources are translated into classroom practices.

Digital literacy encompasses the ability to access, evaluate, manage, and use digital information appropriately, critically, and responsibly. Audrin and Audrin (2022), through a systematic literature review, identify digital literacy as a multidimensional concept relevant to learning and education. Similarly, Dewi et al. (2025) review the implementation of digital literacy in schools, highlighting the importance of understanding how digital literacy is incorporated into educational practice. These studies provide a basis for considering digital literacy as an important educational competency. Nevertheless, the development of digital literacy does not necessarily guarantee improvements in educational quality. Teachers may possess digital skills but still face difficulties integrating technology into pedagogically appropriate learning activities. Thus, the relationship between digital literacy and educational quality needs to be examined not only as a direct relationship but also in terms of the learning processes through which digital competencies may contribute to educational improvement.

Educational infrastructure constitutes another important condition for implementing digital learning. Facilities such as computers, internet access, projectors, and digital learning media can provide opportunities for teachers to diversify instructional strategies and expand access to learning resources. Ayusaputri et al. (2024) discuss the management of educational facilities and infrastructure in relation to the quality of educational services. Other studies cited in this manuscript, including Winandar et al. (2022) and Tuanany and Triwiyanto (2024), address the management of school facilities and the relationship between infrastructure and educational outcomes. Collectively, this line of research emphasizes the importance of educational resources. However, the availability of facilities should be distinguished from their effective use. Infrastructure may create the conditions for learning, but its contribution to educational quality depends on whether teachers can integrate these resources into instructional activities that support student participation and learning objectives. This distinction provides a reason to examine the role of digital learning effectiveness in the relationship between infrastructure and educational quality.

Digital learning effectiveness may help explain how digital competencies and educational resources are translated into educational outcomes. In this study, digital learning effectiveness refers to the extent to which technology-supported learning activities are implemented appropriately and contribute to the achievement of instructional objectives. Educational technology can support student engagement, interaction, and access to learning resources, but these benefits depend on how technology is integrated into teaching practices (Bond & Bedenlier, 2019). From this perspective, teachers' digital literacy can support the selection and use of appropriate digital tools, while adequate infrastructure can provide the resources needed to implement digital learning. When these two conditions are accompanied by effective instructional practices, digital technology has greater potential to support the quality of education. Conversely, digital skills or facilities alone may not be sufficient to improve educational outcomes when they are not translated into effective learning processes.

The existing literature therefore provides complementary insights into digital literacy, infrastructure, and educational quality, but these areas need to be considered together to understand the process connecting educational inputs with educational outcomes. Research on digital literacy emphasizes competencies for accessing and using digital information, while research on infrastructure highlights the availability and management of educational resources. Research on educational technology also draws attention to student engagement and the instructional use of technology. However, these perspectives do not by themselves establish whether digital learning effectiveness explains the relationship of both digital literacy and infrastructure with educational quality in the context examined in this study. The research gap addressed here is therefore specific: the need to empirically examine the direct relationships of digital literacy and infrastructure with educational quality alongside their indirect relationships through digital learning effectiveness within one integrated model.

This issue is relevant to public elementary schools in Serang Regency, where the implementation of digital learning must be considered in relation to teachers' competencies, school resources, and classroom practices. The manuscript reports preliminary administrative figures indicate that 88.05% of public elementary schools were classified in a less profitable category and 11.95% in a good category. However, these figures should be interpreted only after the original data source, reporting period, indicators, and classification criteria have been verified. In particular, results associated with the National Assessment (Computer Based National Assessment—ANBK) should not automatically be treated as direct measures of digital literacy or overall educational quality unless the underlying indicators explicitly measure those constructs. Accordingly, the local context motivates the need to investigate digital learning conditions, but the preliminary figures cannot independently establish the level of digital literacy or educational quality without further clarification of the underlying data.

The proposed model is informed by an input–process–output perspective. In this framework, digital literacy and educational infrastructure are treated as educational inputs, digital learning effectiveness represents the learning process, and educational quality represents the outcome. Digital literacy may support teachers' capacity to select, evaluate, and use digital resources in instructional activities. Infrastructure may provide the technological and physical conditions necessary for those activities. Digital learning effectiveness may then function as the process through which these inputs are translated into more organized, interactive, and goal-oriented learning experiences. This framework provides a theoretical rationale for examining both the direct relationships between the two input variables and educational quality and their indirect relationships through digital learning effectiveness. The model does not assume that all relationships must be significant; Rather, it allows the direct and indirect pathways to be tested empirically.

The study makes two intended contributions. Theoretically, it brings digital literacy and educational infrastructure together within an input–process–output framework to examine digital learning effectiveness as a potential mediating mechanism between educational inputs and educational quality. This approach distinguishes the availability of competencies and resources from their implementation in the learning process. Empirically, the study tests the direct and indirect relationships among these variables using survey data from 264 teachers in public elementary schools in Serang Regency and Structural Equation Modeling–Partial Least Squares (SEM-PLS). By examining the proposed pathways within a single model, the study provides context-specific evidence concerning whether digital learning effectiveness helps explain the relationship of digital literacy and infrastructure with educational quality.

Based on this framework, the study examines seven hypotheses: the direct relationship of digital literacy and infrastructure with educational quality; the relationship of digital literacy and infrastructure with digital learning effectiveness; the relationship between digital learning effectiveness and educational quality; and the two indirect relationships between digital literacy and infrastructure and educational quality through digital learning effectiveness. According to the objective of this study is to analyze the relationship of digital literacy and educational infrastructure with educational quality, both directly and indirectly through digital learning effectiveness, in public elementary schools in Serang Regency..

## 2. RESEARCH METHODS

This study employed a quantitative approach with an explanatory survey method. The quantitative approach was used to measure and analyze the relationship between digital literacy, infrastructure, digital learning effectiveness, and educational quality through statistical hypothesis testing. This study is a causality study, aiming to explain the causal relationship between independent and dependent variables, with a mediating variable aimed at testing the causal relationship between digital literacy and infrastructure variables and educational quality through learning effectiveness as an intervening variable.

The research design used was cross-sectional, meaning data collection was conducted at a specific point in time through a closed-ended Likert-scale questionnaire distributed to public elementary school teachers in Serang Regency. This type of research was chosen because it can measure and analyze the direct and indirect influences between variables based on objective and measurable numerical data. Data analysis was conducted using path analysis techniques to examine the causal influences between variables, in accordance with the research objective of testing hypotheses. The survey design was chosen because it allows for the efficient collection of large amounts of data from various public elementary schools in the research area.

**Population and Sample**

In the initial stages of research, researchers need to first determine the population and sample that will be used as the research object. The population and sampling techniques must be tailored to the objectives, needs, and design of the research to ensure relevant and scientifically sound results.

**Population**

Population is understood as the entire research object that has certain characteristics and criteria as determined by the researcher, which is then used as the basis for the analysis process and drawing conclusions (Sa'id et al., 2024; Sugiyono, 2021). In this study, the defined population includes all public elementary schools in Serang Regency, Banten Province. There are 707 public elementary schools in Serang Regency.

**Table 1 Number of Public Elementary Schools and Teacherseach sub-district**

| Subdistrict | Elementary School (State) | Elementary School Teacher (State) |
|---|---|---|
| Jackfruit | 35 | 300 |
| Padarincang | 38 | 317 |
| Ciomas | 28 | 232 |
| Pabuaran | 19 | 171 |
| Mount Sari | 13 | 97 |
| Baros | 24 | 216 |
| Lightning | 24 | 248 |
| Tunjung Teja | 23 | 212 |
| Cikeusal | 44 | 359 |
| Pamarayan | 25 | 197 |
| Bandung | 18 | 154 |
| Javanese | 17 | 171 |
| Kopo | 20 | 192 |
| Cikande | 32 | 331 |
| Kibin | 20 | 187 |
| Kragilan | 31 | 343 |
| Waringinkurung | 22 | 193 |
| Mancak | 28 | 238 |
| New | 26 | 263 |
| Bojonegara | 22 | 193 |
| Ampel Island | 20 | 188 |
| Kramatwatu | 28 | 352 |
| Ciruas | 32 | 352 |
| Helter-skelter | 26 | 227 |
| Fragrant Lebak | 20 | 169 |
| Swimming | 16 | 155 |
| Binuang | 11 | 132 |
| Tirtayasa | 24 | 204 |
| Tanara | 21 | 176 |
| **Total** | **707** | **6569** |

Source:(BPS Serang City, 2025).

**Sample**

The sampling technique in this study was carried out using the stratified random sampling method. This technique was used

because the population of Public Elementary Schools in Serang Regency is spread across several sub-districts with varying numbers of schools. Therefore, it was necessary to divide the sample proportionally so that each member of the population had an equal opportunity to become a research respondent. The sample size was determined using the Slovin formula as the basis for calculation. The Slovin formula is as follows:

$$n = \frac{N}{1 + Ne2}$$

Where:
n = the desired sample size
N = total population
e = desired margin of error (in decimal form)
The steps in applying the Slovin formula to determine the number of samples with a total population of 707 and a margin of error of 10% include the following steps:
1. Entering the population value (N)
In this study, the population size (N) was 707.
2. Enter margin of error (e)
*Margin of error*used in this study is 10 percent, which if expressed in decimal form is equal to 0.1, because the value of 10 percent is obtained from the ratio of 10 divided by 100, resulting in the number 0.1.
3. Use the Slovin formula

$$n = \frac{N}{1 + Ne2}$$

The substitution values that are owned are:

$$n = \frac{707}{8.07} \qquad x(0,1)^2$$

n = 88 Schools The sample size was determined using the Slovin formula with a 10% error rate, resulting in a total sample size of 88 schools in Serang Regency. The samples were then distributed to each sub-district using proportional random sampling.
The formula used

$$:ni = \frac{Ni}{N} \times n$$

ni = Sample of each sub-district
Ni = School population in the sub-district
N = total population of 707 districts
N = total sample of 88 schools
Example: Cikeusal District, the number of schools in the district is 44 schools.

$$:ni = \frac{Ni}{N} \times n$$

$$:ni = \frac{44}{707} \times 88$$

**n = 5 Schools**

**Table 2**
**List of School Sample Distribution per District**

| No | Subdistrict | Number of Public Elementary Schools | School Sample |
|---|---|---|---|
| 1 | Cikeusal District | 44 | 5 |
| 2 | Padarincang District | 38 | 5 |
| 3 | Cinangka District | 35 | 4 |
| 4 | Cikande District | 32 | 4 |
| 5 | Ciruas District | 32 | 4 |
| 6 | Kramatwatu District | 28 | 3 |
| 7 | Kragilan District | 31 | 4 |
| 8 | Mancak District | 28 | 3 |
| 9 | Ciomas District | 28 | 3 |
| 10 | Anyar District | 26 | 3 |
| 11 | Tirtayasa District | 24 | 3 |
| 12 | Pontang District | 26 | 4 |
| 13 | Pamarayan District | 25 | 3 |
| 14 | Baros District | 24 | 4 |
| 15 | Kopo District | 20 | 2 |
| 16 | Lightning District | 24 | 4 |
| 17 | Waringinkurung District | 22 | 3 |
| 18 | Kibin District | 20 | 2 |
| 19 | Tunjung Teja District | 23 | 3 |
| 20 | Bojonegara District | 22 | 3 |
| 21 | Lebak Wangi District | 20 | 2 |
| 22 | Tanara District | 21 | 3 |
| 23 | Pulo Ampel District | 20 | 2 |
| 24 | Pabuaran District | 19 | 2 |
| 25 | Bandung District | 18 | 2 |
| 26 | Jawilan District | 17 | 2 |
| 27 | Carenang District | 16 | 3 |
| 28 | Gunung Sari District | 13 | 2 |
| 29 | Binuang District | 11 | 1 |

| No | Subdistrict | Number of Public Elementary Schools | School Sample |
|---|---|---|---|
| | **TOTAL** | **707** | **88** |

The next stage, to obtain more representative research data, each sample school was assigned a number of respondent teachers.In this study, each school was represented by 3 teachers using the proportional stratified random sampling technique, using the formula:

**88 : 29 = 3.3 = 3**

So the total research respondents consisted of 88 schools with 264 teachers.

Formula:

Ng Number of Teacher Respondents

Ns Number of Sample Schools

Number of Teachers taken at each School

Ng = Ns x G

**[ 88 x 3 = 264 ]**

**Table 3**
Research Sample List

| No | Subdistrict | Number of Public Elementary Schools | School Sample | Teacher Sample |
|---|---|---|---|---|
| 1 | Cikeusal | 44 | 5 | 15 |
| 2 | Padarincang | 38 | 5 | 15 |
| 3 | Jackfruit | 35 | 4 | 12 |
| 4 | Cikande | 32 | 4 | 12 |
| 5 | Ciruas | 32 | 4 | 12 |
| 6 | Kramatwatu | 28 | 3 | 9 |
| 7 | Kragilan | 31 | 4 | 12 |
| 8 | Mancak | 28 | 3 | 9 |
| 9 | Ciomas | 28 | 3 | 9 |
| 10 | New | 26 | 3 | 9 |
| 11 | Tirtayasa | 24 | 4 | 12 |
| 12 | Helter-skelter | 26 | 3 | 9 |
| 13 | Pamarayan | 25 | 3 | 9 |
| 14 | Baros | 24 | 4 | 12 |
| 15 | Kopo | 20 | 2 | 6 |
| 16 | Lightning | 24 | 4 | 12 |
| 17 | Waringinkurung | 22 | 3 | 9 |
| 18 | Kibin | 20 | 2 | 6 |
| 19 | Tunjung Teja | 23 | 3 | 9 |
| 20 | Bojonegara | 22 | 3 | 9 |
| 21 | Fragrant Lebak | 20 | 2 | 6 |
| 22 | Tanara | 21 | 3 | 9 |
| 23 | Ampel Island | 20 | 2 | 6 |
| 24 | Pabuaran | 19 | 2 | 6 |
| 25 | Bandung | 18 | 2 | 6 |
| 26 | Javanese | 17 | 2 | 6 |
| 27 | Swimming | 16 | 3 | 9 |
| 28 | Mount Sari | 13 | 2 | 6 |
| 29 | Binuang | 11 | 1 | 3 |
| | **Total** | **707** | **88** | **264** |

To maintain the suitability of the data obtained from the selected schools, the following inclusion and exclusion criteria were established:

1. Inclusion Criteria:
   a. Public Elementary School officially registered under the Serang Regency Education Office.
   b. Schools are still actively operating and conducting learning.
   c. Have academic and graduate data for at least the past 3 years.
   d. Willing to be a research subject, marked by the approval of the principal.
2. Exclusion Criteria:
   1. Private schools (SDS) or MI (Madrasah Ibtidaiyah).
   2. SDN which is currently in the administrative whitening or unification stage.

A statistical hypothesis is a tentative answer to a research problem, the validity of which must be verified through data collection and analysis. Hypotheses are formulated based on theoretical foundations, previous research findings, and a previously formulated framework. In quantitative research, statistical hypotheses serve as the basis for testing the presence or absence of influences between variables.

1. First hypothesis
$H0_1 : \beta_1 = 0$
$Ha_1 : \beta_1 \neq 0$
2. Second hypothesis
$H0_2 : \beta_2 = 0$
$Ha_2 : \beta_2 \neq 0$
3. The third hypothesis
$H0_3 : \beta_3 = 0$
$Ha_3 : \beta_3 \neq 0$
4. The fourth hypothesis
$H0_4 : \beta_4 = 0$
$Ha_4 : \beta_4 \neq 0$
5. Fifth hypothesis
$H0_5 : \beta_5 = 0$
$Ha_5 : \beta_5 \neq 0$
6. The sixth hypothesis
$H0_6 : \beta_6 = 0$
$Ha_6 : \beta_6 \neq 0$
7. The seventh hypothesis
$H0_7 : \beta_7 = 0$
$Ha_7 : \beta_7 \neq 0$

In this study, a statistical hypothesis is formulated to test the influence of digital literacy and infrastructure on the quality of education, both directly and indirectly through learning effectiveness as a mediating variable in Public Elementary Schools in Serang Regency.

## 3. RESEARCH RESULTS AND DISCUSSION

### Direct Effect Test Results(direct effect) with*Bootstrapping*

Direct effect testing was conducted to determine whether there was a direct influence between latent variables in the research model. This analysis used the bootstrapping procedure in the SmartPLS 4 application to obtain the path coefficient, t-statistic, and p-value of each hypothesized relationship between variables. The decision on the hypothesis was based on a 5% significance level ($\alpha = 0.05$). A hypothesis was accepted if the p-value was less than 0.05 (p-value < 0.05). In addition, based on a two-tailed test, the hypothesis was also

declared significant if the t-statistic was greater than 1.96 (t-statistic > 1.96). Conversely, if the p-value was greater than 0.05 or the t-statistic was less than or equal to 1.96, then the relationship between the variables was declared insignificant and the hypothesis was rejected. Test results*direct effect*presented asfollowing:

**Table 4.21 Results of Direct Effect Testing(direct effect)**

| Path Coefficient | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (\|O/STDEV\|) | P values | Significant Level |
|---|---|---|---|---|---|---|
| Digital Literacy -> Quality of Education | 0.010 | 0.013 | 0.055 | 0.177 | 0.430 | Not Significant |
| Facilities and Infrastructure -> Quality of Education | 0.145 | 0.138 | 0.099 | 1,471 | 0.071 | Not Significant |
| Digital Literacy -> Learning Effectiveness | 0.122 | 0.127 | 0.049 | 2,478 | 0.007 | Significant |
| Facilities and Infrastructure -> Learning Effectiveness | 0.758 | 0.755 | 0.045 | 16,963 | 0.000 | Significant |
| Learning Effectiveness -> Education Quality | 0.563 | 0.566 | 0.096 | 5,847 | 0.000 | Significant |

Based on the test results in Table 4.21,The following description can be used in the sectionhypothesis test results (bootstrapping).

Based on the bootstrapping test results, hypothesis testing was conducted by examining the t-statistics and p-values. A hypothesis is accepted if the t-statistics value is > 1.96 and the p-value is < 0.05 at a 5% significance level.

The test results show that Learning Effectiveness has a positive and significant effect on the Quality of Education, with a path coefficient value (Original Sample) of 0.563, a t-statistic value of 5.847, and p-values of 0.000. This indicates that the higher the effectiveness of learning, the higher the quality of education.

The Digital Literacy variable has a positive and significant effect on Learning Effectiveness, as indicated by a path coefficient value of 0.122, a t-statistic value of 2.478, and a p-value of 0.007. Thus, increasing digital literacy can increase learning effectiveness.

On the other hand, digital literacy has no significant effect on educational quality, despite having a positive path coefficient of 0.010. This is indicated by the t-statistic of 0.177, which is smaller than 1.96, and the p-value of 0.430, which is greater than 0.05. Therefore, the hypothesis regarding the direct effect of digital literacy on educational quality is rejected.

Furthermore, infrastructure has a positive and significant effect on learning effectiveness, with a path coefficient of 0.758, a t-statistic value of 16.963, and a p-value of 0.000. These results indicate that the availability of adequate facilities and infrastructure can significantly increase learning effectiveness.

Meanwhile, infrastructure does not significantly influence educational quality, despite having a positive relationship with a path coefficient of 0.145. This is proven by the t-statistic value of 1.471, which is smaller than 1.96, and the p-value of 0.071, which is greater than 0.05. Therefore, the hypothesis is rejected.

Overall, the test results show that of the five relationships tested, three have a positive and significant effect, namely learning effectiveness on educational quality, digital literacy on learning effectiveness, and infrastructure on learning effectiveness. Meanwhile, digital literacy on educational quality and infrastructure on educational quality do not show a significant effect. These results indicate that learning effectiveness acts as a bridging variable between the influence of digital literacy and infrastructure on educational quality.

**Results of Indirect Effect Testing(indirect effect) withB*ootstrapping***

The indirect effect test was conducted to determine whether Digital Learning Effectiveness (Z) was able to mediate the relationship between Digital Literacy ($X_1$) and Infrastructure ($X_2$) on Education Quality (Y). The test was conducted using the bootstrapping procedure in SmartPLS by looking at the Original Sample (O) value, t-statistic, and p-value. A mediation effect is declared significant if it has a t-statistic value > 1.96 and a p-value < 0.05 at a significance level of 5%.(Hair et al., 2022). The following table shows the results of the indirect effect test results.*Effect Size ($f^2$)*presented asfollowing:

**Table 4.22 Results of the Indirect Effect Test).**

| Path Coefficient | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (\|O/STDEV\|) | P values | Significant Level |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Digital Literacy -> Quality of Education | 0.069 | 0.072 | 0.031 | 2,241 | 0.013 | Significant |
| Facilities and Infrastructure -> Quality of Education | 0.427 | 0.428 | 0.081 | 5,270 | 0.000 | Significant |

Based on the test results in Table 4.19, the following is a description that can be used for the results of the indirect effect/mediation test.

Based on the results of the indirect effect test through the Learning Effectiveness variable, it was found that Digital Literacy has a positive and significant effect on the Quality of Education through Learning Effectiveness. This is indicated by the path coefficient value (Original Sample) of 0.069, t-statistics value of 2.241, and p-values of 0.013, which meet the significance criteria (t-statistics > 1.96 and p-values < 0.05). These results indicate that Learning Effectiveness is able to mediate the effect of Digital Literacy on the Quality of Education, so that increasing digital literacy can improve the quality of education through increasing learning effectiveness.

Furthermore, infrastructure also has a positive and significant effect on educational quality through learning effectiveness. This is proven by a path coefficient of 0.427, a t-statistic of 5.270, and a p-value of 0.000, thus accepting the mediation hypothesis. These results indicate that infrastructure influences educational quality indirectly through increased learning effectiveness.

Overall, the results of the indirect effect test indicate that learning effectiveness acts as a mediating variable in the relationship between digital literacy and educational quality, as well as between infrastructure and educational quality. Considering that in the previous test, the direct effect of digital literacy on educational quality and infrastructure on educational quality was insignificant, while the indirect effect of both was significant, learning effectiveness acts as a full mediator in both relationships. Thus, improving educational quality is more effectively achieved through increasing learning effectiveness supported by digital literacy and adequate infrastructure.

**Discussion of Research Results**

**The Impact of Digital Literacy on the Quality of Education**

The results of the hypothesis testing indicate that Digital Literacy does not significantly influence the Quality of Education. Based on the results of the analysis using SmartPLS, the path coefficient value (Original Sample) was 0.010, the t-statistic value was 0.177, and the p-value was 0.430. A t-statistic value smaller than 1.96 and a p-value greater than 0.05 indicate that Hypothesis 1 is rejected. Thus, increasing teachers' digital literacy has not been able to provide a significant direct influence on improving the quality of education in Public Elementary Schools in Serang Regency.

These findings indicate that although teachers possess the ability to utilize digital technology, this competency does not automatically improve the quality of education. Educational quality is a complex concept influenced by various factors, such as the effectiveness of the learning process, the quality of school management, the principal's leadership, the availability of infrastructure, school culture, and student learning outcomes. Therefore, digital literacy plays a more supportive role, requiring implementation through effective digital learning before it can lead to improvements in educational quality. In other words, teachers' digital skills need to be embodied in quality learning practices to impact the overall quality of education.

Theoretically, the results of this study contribute to the development of General Systems Theory by demonstrating that improving the quality of education is not sufficient only through increasing teachers' digital competence as input, but also requires an effective digital learning process as a transformation mechanism towards quality output. Practically, the results of this study provide the implication that programs to improve teachers' digital literacy must be integrated with improvements in the quality of digital learning so that the benefits of digital competence can be felt tangibly in improving the quality of education.

**The Influence of Facilities and Infrastructure on the Quality of Education**

The results of the hypothesis testing indicate that infrastructure does not significantly influence the quality of education. Based on the results of the SmartPLS analysis, the path coefficient value was 0.145, the t-statistic value was 1.471, and the p-value was 0.071. These values indicate that Hypothesis 2 is rejected because the t-statistic value is less than 1.96 and the p-value is greater than 0.05. Thus, improving infrastructure has not been able to provide a direct influence on improving the quality of education.

These findings indicate that the existence of educational facilities and infrastructure, while important, is not sufficient to improve the quality of education if it is not utilized optimally in the learning process. Educational infrastructure only provides a supportive environment for learning activities, while improving educational quality is largely determined by how these facilities are used by teachers and students to create effective learning. Therefore, the success of improving educational quality is more influenced by the quality of infrastructure utilization than simply its availability.

Theoretically, this research reinforces the view that infrastructure is a supporting factor that requires a process mechanism before it can improve educational quality. Practically, the research results indicate that infrastructure procurement policies must be accompanied by increased teacher competency in using these facilities to ensure that the investment truly impacts educational quality.

**Digital Literacy has a positive and significant impact on Learning Effectiveness**Digital.

Based on the analysis results using SmartPLS, the path coefficient value (Original Sample) was 0.122, the t-statistic value was 2.478, and the p-value was 0.007. A t-statistic value greater than 1.96 and a p-value smaller than 0.05 indicate that Hypothesis 3 is accepted. This finding indicates that the higher the level of digital literacy possessed by

teachers, the better the effectiveness of digital learning implemented in elementary schools. Although the magnitude of the influence is relatively small compared to other variables in the research model, the relationship still has a significant statistical meaning so that digital literacy is one of the factors contributing to the successful implementation of technology-based learning.

These results indicate that teachers' ability to access, evaluate, manage, and utilize information and digital technology can improve the quality of the learning process. Teachers with good digital literacy will more easily select appropriate learning platforms, develop interactive learning media, utilize various educational applications, and develop engaging and easily understood digital learning materials for students. These skills provide a more active, collaborative, and student-centered learning experience, enabling learning objectives to be achieved more effectively. Therefore, improving teachers' digital literacy not only contributes to improving individual competency but also impacts the quality of the learning process in schools.

**Infrastructure has a positive and significant effect on the effectiveness of digital learning.**.

Based on the results of the SmartPLS analysis, the path coefficient value was 0.758, the t-statistic value was 16.963, and the p-value was 0.000, thus Hypothesis 4 was accepted. These coefficient values indicate that infrastructure is the variable with the strongest influence on the effectiveness of digital learning compared to other variables in the research model. This finding indicates that the more complete and adequate the infrastructure facilities owned by the school, the more effective the implementation of digital learning carried out by teachers.

The availability of technological devices such as computers, laptops, projectors, internet connections, multimedia devices, and digital learning media significantly supports the success of the learning process. Adequate infrastructure enables teachers to deliver learning materials in a more engaging manner, facilitates more intensive interactions between teachers and students, and provides easy access to various digital learning resources. On the other hand, limited facilities will hinder the implementation of digital learning, even if teachers possess strong digital competencies. Therefore, the success of digital learning transformation depends not only on teacher skills but also greatly on the readiness of the educational infrastructure available at the school.

These findings reinforce the provisions of the Ministry of Education, Culture, Research, and Technology Regulation Number 22 of 2023, which emphasizes that educational facilities and infrastructure are one of the standards that must be met to support the implementation of a quality learning process. The results of this study are also in line with the General System Theory (GST), which explains that facilities and infrastructure are input components in the education system that influence the quality of the learning process. The better the quality of input in the form of educational facilities, the more optimal the digital learning process will be, resulting in an output in the form of improved educational quality. Furthermore, Constructivism Theory also explains that a learning environment supported by technology and adequate learning resources will provide opportunities for students to actively construct knowledge through more meaningful, collaborative, and contextual learning experiences. Thus, facilities and infrastructure function not only as physical facilities but also as strategic factors in creating a learning environment that supports the achievement of effective learning.

**The Influence of Digital Learning Effectiveness on Education Quality**

The results of the hypothesis testing indicate that the Effectiveness of Digital Learning has a positive and significant effect on the Quality of Education. Based on the analysis results using SmartPLS, the path coefficient value was 0.563, the t-statistic value was 5.847, and the p-value was 0.000. These values indicate that Hypothesis 5 is accepted. This means that the higher the effectiveness of digital learning implemented by teachers, the higher the quality of education produced in Public Elementary Schools in Serang Regency.

These findings indicate that the effectiveness of digital learning is a crucial factor in improving educational quality. Systematically designed, interactive, collaborative, and student-centered digital learning can enhance the quality of the teaching and learning process, resulting in improved learning outcomes, student engagement, and the achievement of educational goals. Therefore, the effectiveness of digital learning is a key mechanism connecting various educational resources to improved educational quality.

Theoretically, this research strengthens Constructivism Theory, General System Theory, and Total Quality Management in explaining that the quality of the learning process is a strategic factor in improving the quality of education. Practically, the research results imply that local governments, principals, and teachers need to focus various quality improvement programs on strengthening the quality of digital learning processes through teacher competency development, learning innovation, the use of educational technology, and continuous learning evaluation so that optimal improvements in education quality can be achieved.

**The Influence of Digital Literacy on the Quality of Education through the Effectiveness of Digital Learning**

The results of the hypothesis testing indicate that the Effectiveness of Digital Learning is able to significantly mediate the influence of Digital Literacy on the Quality of Education. Based on the results of the SmartPLS bootstrapping analysis, the indirect effect coefficient value was obtained at 0.069, the t-statistic value was 2.306, and the p-value was 0.011. A t-statistic value greater than 1.96 and a p-value smaller than 0.05 indicate that Hypothesis 6 is accepted. These results indicate that the influence of digital literacy on the quality of education does not directly, but through increasing the occurrence of the effectiveness of digital learning as a mediating variable.

These findings suggest that teachers' ability to utilize digital technology is insufficient to improve educational quality if it is not translated into effective learning practices. Digital literacy is a competency that enables teachers to access various learning resources, utilize educational applications, develop interactive learning media, and manage technology-based learning. However, the benefits of this competency will only impact educational quality if it is implemented in a digital learning process that increases student engagement, the effectiveness of material delivery, and the achievement of learning objectives. Therefore, the effectiveness of digital learning serves as a mechanism that transforms teachers' digital competency into improved educational quality.

Theoretically, the results of this study expand the application of General Systems Theory, Digital Competence Framework, and Constructivism Theory in explaining the mechanisms for improving educational quality through the transformation of teachers' digital competencies into effective learning processes. Practically, the results of this study provide implications that improving teachers' digital literacy needs to be accompanied by improving pedagogical skills in integrating technology into learning. Teacher training programs should not only focus on technological mastery but also on technology implementation strategies to create effective digital learning, thereby sustainably improving educational quality.

**The Influence of Facilities and Infrastructure on the Quality of Education through the Effectiveness of Digital Learning**

The results of the hypothesis testing indicate that the Effectiveness of Digital Learning is able to significantly mediate the influence of Infrastructure on the Quality of Education. Based on the results of the SmartPLS bootstrapping analysis, the indirect effect coefficient value was obtained at 0.427, the t-statistic value was 5.444, and the p-value was 0.000. A t-statistic value greater than 1.96 and a p-value smaller than 0.05 indicate that Hypothesis 7 is accepted. This finding indicates that infrastructure does not directly improve the quality of education, but provides an influence through increasing the effectiveness of digital learning.

These results indicate that educational facilities such as information technology devices, internet networks, digital learning media, computers, laptops, and other supporting devices will only contribute to educational quality if they are optimally utilized in the learning process. Educational infrastructure only provides a supportive educational environment, while improving quality is determined by how teachers use these facilities to create effective, interactive, innovative, and student-centered learning. Therefore, the effectiveness of digital learning is a crucial factor linking the use of infrastructure and improving educational quality.

Theoretically, this study strengthens General System Theory, Constructivism Theory, and educational infrastructure standards policy by demonstrating that the effectiveness of digital learning is a crucial component of the process that determines the success of transforming input into quality educational output. Practically, the study's findings imply that local governments, education offices, and school principals need not only improve the provision of educational infrastructure but also ensure that all facilities are optimally utilized through teacher competency enhancement, digital learning model development, and continuous evaluation of the effectiveness of digital learning implementation. Therefore, investment in educational infrastructure will have a tangible impact on improving the quality of education at Serang Regency Public Elementary Schools.

## 4. CONCLUSION

This study examined the relationship between digital literacy, educational infrastructure, digital learning effectiveness, and educational quality in public elementary schools in Serang Regency. The findings indicate that digital literacy and educational infrastructure do not have statistically significant direct effects on educational quality at the 5% significance level. However, both variables are reported to have positive and statistically significant indirect effects on educational quality through digital learning effectiveness. These findings highlight the potential mediating role of digital learning effectiveness in the relationship between digital literacy, educational infrastructure, and educational quality.The main contribution of this study lies in highlighting the role of digital learning effectiveness as a potential mechanism through which digital literacy and educational infrastructure are associated with educational quality. The findings suggest that the contribution of digital literacy and educational infrastructure to educational quality should not be considered solely in terms of their direct relationships, but also in relation to the effectiveness with which digital technologies are integrated into the learning process.In practical terms, schools and education policymakers in Serang Regency should consider strengthening teachers' digital literacy, improving access to and the availability of educational infrastructure, and supporting the effective integration of digital technologies into classroom activities. These efforts should be accompanied by appropriate teacher training and support to ensure that digital resources contribute meaningfully to the learning process.

Nevertheless, the findings should be interpreted within the context of public elementary schools in Serang Regency and should not be generalized to all elementary schools in Indonesia without further empirical evidence. Future research could involve schools from different regions, examine a broader range of educational contexts, and investigate additional factors that may influence the relationship between digital literacy, educational infrastructure, digital learning effectiveness, and educational quality. Further studies could also employ longitudinal designs to examine how these relationships develop over time.

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