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Analysis of The Influence of Digital Infrastructure on Students' Learning Outcomes at Al-Birru Elementary School, Sukabumi District

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Abstract

This study aims to analyze the effect of digital infrastructure on student learning outcomes at SD Albirru, Sukabumi Regency. Adequate digital infrastructure is believed to increase the effectiveness of learning, which leads to improved student academic outcomes. This study uses a quantitative approach with a descriptive correlational research design. The research sample consisted of teachers and parents of students involved in digital learning at SD Albirru, with a total of 50 respondents selected using a census sampling technique where the entire population was sampled. Data were collected through closed questionnaires that had been tested for validity and reliability, then analyzed using multiple regression with the help of SPSS 26. The results of the study indicate that digital infrastructure has a significant positive effect on student learning outcomes, where improving the quality of digital infrastructure (such as stable internet access, adequate hardware, and digital learning platforms) contributes to improving student academic outcomes. This finding is in line with previous studies that emphasize the importance of digital infrastructure in supporting more effective learning. Based on the results of the study, it is recommended to improve the quality of digital infrastructure in schools to create a more interactive and enjoyable learning environment. This study also contributes to the development of technology-based education policies at the elementary school level.

Keywords *digital infrastructure, student learning outcomes, elementary education, digital learning.*

INTRODUCTION

In the digital era, technology has become an important element that is inseparable from various aspects of human life, including education. 21st-century education demands the integration of technology in the teaching and learning process to create learning experiences that are relevant and adaptive to future needs (Kusumawati & Santoso, 2023). Digital infrastructure, such as internet access, computer hardware, and online learning platforms, play an important role in facilitating the accessibility and effectiveness of learning. With adequate digital infrastructure, students can obtain information, collaborate, and develop 21st-century skills such as critical thinking, creativity, and digital literacy (Haryanto & Widodo, 2021).

However, in Indonesia, the inequality in the availability of digital infrastructure remains a major challenge. Data shows that there is a significant disparity between urban and rural areas in terms of access to educational technology. In rural areas, such as Sukabumi Regency, schools often face limited resources to support technology-based learning (Setiawan et al., 2021). This condition can impact the quality of education received by students and ultimately affect their learning outcomes.

Student learning outcomes are an important indicator in assessing the effectiveness of education. Previous studies have shown that adequate digital infrastructure can improve learning motivation, student engagement, and academic achievement (Suryani et al., 2022).

However, the influence of digital infrastructure on learning outcomes at the elementary school level, especially in rural areas such as Sukabumi Regency, has not been widely studied. Therefore, it is important to explore the extent to which digital infrastructure at SD Albirru can affect student learning outcomes.

Digital infrastructure includes all devices, technologies, and services used to support technology-based teaching and learning processes. In the context of education, digital infrastructure includes hardware such as computers, laptops or projectors; learning software and adequate internet services to access information and learning resources online (Haryanto & Widodo, 2021).

The existence of adequate digital infrastructure can make it easier for teachers to deliver materials, provide richer learning access, and enable students to access various relevant educational resources. However, in rural areas such as Sukabumi Regency, the availability of digital infrastructure is often limited. Problems such as slow internet connections, lack of technological devices in schools, and operational costs are the main obstacles in implementing digital technology in elementary school environments (Setiawan et al., 2021).

Previous research shows that good digital infrastructure can increase student engagement in learning, facilitate independent learning, and encourage mastery of 21st-century skills (Kusumawati & Santoso, 2023). Thus, digital infrastructure is not only a complement to learning, but also an important element that determines the success of implementing modern education.

Student learning outcomes are the main indicator in assessing the success of the educational process. Learning outcomes reflect the extent to which students have achieved the expected competencies based on the applicable curriculum. Learning outcomes can be measured through academic grades, conceptual understanding, critical thinking skills, and students' social and emotional skills (Rahmawati et al., 2022).

The factors that influence student learning outcomes are very diverse, ranging from teaching quality, learning environment, to the use of educational technology. Research shows that the use of digital technology in learning can have a positive impact on student learning outcomes by enriching teaching methods, providing access to extensive learning resources, and increasing student engagement in the learning process (Suryani et al., 2022).

However, without adequate digital infrastructure, these positive impacts are difficult to achieve. Conversely, lack of access to technology can lead to gaps in academic achievement between students living in urban and rural areas (Rahmawati et al., 2022). At SD Albirru, student learning outcomes are affected by the limitations of available technology, so an analysis is needed to understand the extent to which digital infrastructure affects student learning outcomes in this environment.

This study aims to analyze the relationship between digital infrastructure and student learning outcomes at Albirru Elementary School, Sukabumi Regency. Using a quantitative approach through regression analysis, this study seeks to provide empirical insight into the impact of digital technology on elementary education. In addition, the results of this study are expected to provide practical recommendations for schools, local governments, and other

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stakeholders in developing more inclusive and effective technology-based education policies.

SD Albirru, an elementary school in Sukabumi Regency, has begun implementing the use of digital technology in learning as part of an effort to improve the quality of education. The school has adopted several technology-based initiatives, such as the use of online learning applications, interactive projectors, and limited internet access to support teaching and learning activities. However, this implementation faces various challenges, including limited infrastructure, teachers' digital competence, and the affordability of technology for students from low-income backgrounds (Rahmawati et al., 2022).

Digital infrastructure at SD Albirru Sukabumi Regency is currently still limited and does not fully support effective learning, so it is important to know how digital infrastructure affects student learning outcomes at the school. This study also aims to identify the extent to which digital infrastructure can affect student academic achievement. Thus, this study is expected to provide a clear picture of the relationship between digital infrastructure and the quality of learning outcomes at the elementary school level at SD Albirru Sukabumi Regency.

LITERATURE REVIEW

Digital Infrastructure in Education

Digital infrastructure refers to hardware, software, and technological resources that support the implementation of technology-based education. According to Haryanto & Widodo (2021), digital infrastructure includes various elements, such as computer or tablet devices, a stable internet network, and online learning platforms that allow access to learning materials and interaction between teachers and students. Adequate digital infrastructure is a key factor supporting the success of technology-based learning, as emphasized by Kusumawati & Santoso (2023), who show that the integration of technology in education requires strong infrastructure to create an effective and efficient learning environment.

However, in many areas, especially in rural areas, digital infrastructure is still very limited. Setiawan et al. (2021) found that limited internet access, lack of learning devices, and low quality of technological resources are the main challenges in implementing technology-based learning in many schools. At SD Albirru, Sukabumi Regency, although there are efforts to use technology in learning, limited digital infrastructure can be an obstacle in maximizing the potential of technology to improve the quality of learning.

The Impact of Digital Infrastructure on Student Learning Outcomes

Student learning outcomes refer to the level of competency attainment achieved by students in various subjects or skills after following the learning process. Learning outcomes are often measured through tests or evaluations to measure the extent to which students understand the subject matter and apply it in the context of everyday life (Rahmawati et al., 2022). One of the factors that can affect student learning outcomes is the quality and availability of digital infrastructure. According to Suryani et al. (2022), adequate digital

infrastructure can improve the quality of learning, enrich the learning experience, and help students access various relevant educational resources.

Research by Kusumawati & Santoso (2023) also shows that good digital infrastructure can increase student engagement in the learning process and support the development of 21st century skills, such as critical thinking and creativity. However, if the digital infrastructure is inadequate, this can reduce the quality of learning and, in turn, hinder student learning outcomes. This is very relevant to the context of SD Albirru, Sukabumi Regency, where limited digital infrastructure may have an impact on students' academic achievement.

Factors Affecting Learning Outcomes

In addition to digital infrastructure, other factors that can affect student learning outcomes are the quality of teaching, student motivation, and family and school environment support. Rahmawati et al. (2022) stated that although technology can support learning, the success of its implementation is highly dependent on the teacher's skills in utilizing the technology in learning. In other words, the quality of teaching and the digital competence of teachers play an important role in determining how effectively technology can be used to improve student learning outcomes.

In addition, students' motivational factors also affect their engagement in learning. Research by Setiawan et al. (2021) shows that students who have better access to technology and educational resources tend to be more motivated to learn. These factors need to be considered in analyzing the influence of digital infrastructure on student learning outcomes.

Education Gap and Digitalization

The educational gap between urban and rural areas is a major challenge in implementing digital-based education. In Indonesia, this gap is increasingly felt with unequal access to technology, both in terms of the quality and quantity of digital infrastructure in schools. In urban areas, many schools have been equipped with modern technology that supports learning, while in many rural areas, including Sukabumi Regency, there are still limitations to these facilities. Setiawan et al. (2021) showed that this gap has an impact on the differences in the quality of education received by students, where students in areas with limited access to technology tend to have lower academic achievement compared to students in areas with better digital infrastructure.

In addition, research by Rahmawati et al. (2022) shows that the existence of a digital divide exacerbates the inequality in educational achievement that could have been overcome with more equitable technology integration. Inadequate digital infrastructure prevents students from accessing various learning materials, especially amidst the growing demands of online learning. Therefore, the digital divide is an important issue that needs to be considered in efforts to improve the quality of education, especially in the context of implementing technology for effective learning.

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METHOD

Types of research

This study uses a quantitative research method with a descriptive approach. This study aims to analyze the influence of digital infrastructure on student learning outcomes at SD Albirru, Sukabumi Regency, by involving teachers and parents of students as respondents. Digital infrastructure is considered an independent variable measured by several indicators, while student learning outcomes are measured as dependent variables.

Population and Sample

The population in this study were teachers who teach at Albirru Elementary School, Sukabumi Regency and parents of students from grades V and VI who are involved in learning using digital infrastructure. It is known that the total number of teachers is 10 and the number of parents is 40 people. The sampling technique used is the census method by taking samples from the entire population. This number will be used for data analysis.

Data collection technique

The data used in this study are primary data obtained through a closed questionnaire distributed to teachers and parents of students at Albirru Elementary School. The questionnaire consists of two parts:

1) Digital infrastructure as an independent variable, which includes aspects such as the availability of hardware, internet network, and the use of digital learning platforms used to support the learning process.
2) Student learning outcomes as the dependent variable, which is measured based on teacher perceptions of student academic achievement and parent perceptions of their child's academic progress.

Before the questionnaire was used for data collection, the instrument was first tested to test validity and reliability using SPSS 26 software.

Data Analysis Techniques

In this study, data analysis was carried out using regression analysis. This method is used to determine how much influence digital infrastructure has on student learning outcomes by controlling various other variables. The analysis process is carried out through the following stages: (a) Descriptive Statistics to provide an overview of the data obtained from respondents, including the average, standard deviation, and frequency distribution of the variables measured. (b) Multiple Regression to test the influence of digital infrastructure on student learning outcomes, taking into account the influence of several other factors that may affect learning outcomes. (c) Hypothesis Testing using the t-Test to determine whether the influence of digital infrastructure on student learning outcomes is statistically significant.

RESULT AND DISCUSSION

Respondent Identity

The identity of the respondents in this study is very important to provide a clearer picture of the background and characteristics of the samples involved in the study. It will be explained that gender, education level, and age range will be considered to describe the diversity of the respondent profiles presented as follows.

Table 1. Respondent Identity Gender

	Frequency	Percent
MALE	24	48,0
FEMALE	26	52,0
Amount	50	100,0

Data source: processed, 2024

Based on the results of the analysis of the respondents' identities, this study involved 50 respondents, consisting of teachers and parents of students at Albirru Elementary School, Sukabumi Regency. Overall, the majority of respondents were female, with 52% female respondents and 48% male respondents. This gender composition shows a relatively even balance, although there are slightly more female respondents. This may reflect the active role of women, both as teachers and parents of students, in decision-making regarding their children's education.

Table 2. Respondents' Education Identity

	Frequency	Percent
DIPLOMA	20	40,0
BACHELOR	15	30,0
SENIOR HIGH SCHOOL	15	30,0
Amount	50	100,0

Data source: processed, 2024

Regarding education level, the majority of respondents have education above Senior High School (SLTA). As many as 40% of respondents have a Diploma (D3) education background, while 30% of respondents have a high school education and another 30% have a Bachelor's degree (S1). The dominance of respondents with D3 education may be related to the large number of teachers or parents who have a fairly in-depth vocational or professional education background, while the smaller proportion with a S1 degree indicates a need to expand the level of education among respondents.

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Table 3. Respondents' Age Identity

		Frequency	Percent
Valid	20-30	5	10,0
	31-40	35	70,0
	41-50	10	20,0
	Amount	50	100,0

Data source: processed, 2024

In terms of age, most respondents, 40%, are in the age range of 31 to 40 years. This group dominates because they are of productive age who have more work experience and are more open to the use of technology in education. Meanwhile, the age groups of 20-30 years and 41-50 years each account for 30% of respondents. The young age group (20-30 years) may be more accustomed to the use of technology, while the age group of 41-50 years is more experienced in the world of education but may have their own challenges in adapting to rapid technological developments.

Termination Test

Determination test to measure how much influence the independent variable (digital infrastructure) has on the dependent variable (student learning outcomes). Presented as follows.

Table 4. Termination Test

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,377[a]	,142	,124	4,832

a. Predictors: (Constant), Digital Infrastructure (X1)

Based on the results of the determination test obtained, the R^2 value (coefficient of determination) is 0.142 or 14.2%. This means that 14.2% of the variation in student learning outcomes can be explained by the digital infrastructure in SD Albirru, Sukabumi Regency. In other words, 14.2% of the changes that occur in student learning outcomes can be influenced by the quality and existence of digital infrastructure in schools. Most of the variability in student learning outcomes (around 85.8%) is influenced by other factors that were not measured in this study.

F-test (Model feasibility)

The F test is used to test the model formed whether it has a feasible or fit model. If the results show a siq value <0.05 then the model formed shows a fit model. Presented as follows.

Table 5. F-test

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	185,949	1	185,949	7,965	,007[b]
	Residual	1120,631	48	23,346		
	Total	1306,580	49			

a. Dependent Variable: Student Learning Outcomes (Y)

b. Predictors: (Constant), Digital Infrastructure (X1)

The F test results show an F-count value of 7.965 with a sig value (p-value) of 0.007. It can be concluded that digital infrastructure on student learning outcomes in the regression model used in this study has good model feasibility.

T-Test

The t-test is used to test the effect of each independent variable (in this case, digital infrastructure) on the dependent variable (student learning outcomes) in the regression model. Presented as follows.

Table 6. t-test

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	185,949	1	185,949	7,965	,007[b]
	Residual	1120,631	48	23,346		
	Total	1306,580	49			

a. Dependent Variable: Student Learning Outcomes (Y)

b. Predictors: (Constant), Digital Infrastructure (X1)

Based on the results of the t-test conducted, it will be interpreted as follows:

1) Beta = 0.374: A beta value of 0.374 indicates that for every one unit increase in digital infrastructure, student learning outcomes are expected to increase by 0.374 units. This indicates a positive relationship between digital infrastructure and student learning outcomes, where the better the digital infrastructure, the better the student learning outcomes.
2) t-statistic = 2.822: The t-statistic value of 2.822 is greater than the t-table value at a significance level of 0.05 (with a threshold value of 1.97 for samples below 100). This indicates that the regression coefficient for digital infrastructure is significantly different from zero, meaning that digital infrastructure has a significant influence on student learning outcomes.
3) p-value = 0.007: The p-value of 0.007 is smaller than the significance level of 0.05. This indicates that H0: stating that there is no influence of digital infrastructure on student

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learning outcomes) is rejected. In other words, the results of this t-test indicate that digital infrastructure has a significant influence on student learning outcomes.

Based on the results of the research that has been conducted, it is proven that digital infrastructure has a significant positive influence on student learning outcomes at SD Albirru, Sukabumi Regency. This finding is in line with a number of previous studies showing that the existence of adequate digital infrastructure, such as adequate hardware, stable internet connectivity, and access to digital learning platforms, can increase the effectiveness of learning and, in turn, students' academic outcomes Tanuwijaya (2020).

This study revealed that students who study in an environment supported by good digital infrastructure show a significant increase in academic achievement compared to students who study using limited educational facilities. This reflects that digital technology can expand access to more diverse learning materials and increase student engagement in the learning process. This is in line with research by Tanuwijaya (2020) which states that digital infrastructure plays an important role in creating a more interactive and enjoyable learning environment, which has a positive effect on student learning outcomes.

In addition, the results of this study also strengthen the findings of Sutrisno et al. (2021), which states that the integration of technology in the learning process can increase students' learning motivation, which in turn will improve their learning outcomes. Technology provides opportunities for students to learn independently through more varied learning materials that can be adjusted to the learning needs of each student.

Sutrisno et al. (2021) also found that the main factors influencing the improvement of student learning outcomes were the quality of internet connection and available access to digital learning devices. These findings are consistent with the results of this study, which show that the existence of quality digital infrastructure at SD Albirru, Sukabumi Regency provides better access for students to learn, both inside and outside school hours.

In addition, Sari (2022) stated that the use of digital media in learning provides a more comprehensive experience for students. This includes the use of learning applications, interactive videos, and simulations that can help students understand more complex concepts more easily and interestingly. In this study, it was also found that students who use digital infrastructure well tend to be more active and interested in the learning process, which ultimately contributes to improving their learning outcomes.

Thus, the results of this study confirm that digital infrastructure has a very important role in improving student learning outcomes. The existence of adequate technology not only provides wider access to information, but also creates a more effective and enjoyable learning environment, which directly contributes to improving student academic achievement.

CLOSING

Conclusion

Based on the results of the research conducted, it can be concluded that digital infrastructure has a significant positive effect on student learning outcomes at SD Albirru, Sukabumi Regency. This study proves that the availability of adequate digital infrastructure,

including hardware, internet connectivity, and access to digital learning platforms, can improve learning effectiveness and support student academic achievement. This is in line with the findings of previous studies showing that the use of technology in learning can improve student motivation, engagement, and learning outcomes.

Thus, it is important for schools to continue to improve the quality of existing digital infrastructure, in order to create a more effective learning environment and support students' academic success. This study also shows that the development of digital infrastructure at the elementary school level is very relevant in facing the challenges of learning in the increasingly developing digital era.

This research makes an important contribution to understanding the relationship between digital infrastructure and student learning outcomes, and provides recommendations for further development in the field of technology-based education.

Research Limitations

The results of the research that has been conducted contain several research limitations as follows:

1) Limited Sample: This study only involved teachers and parents of students in one school (SD Albirru, Sukabumi Regency). Therefore, the results of this study may not be fully generalizable to other schools in different regions or at higher levels of education.
2) Type of Data Used: This study relies on primary data obtained through questionnaires distributed to teachers and parents of students. Although the instruments have been tested for validity and reliability, the data obtained are subjective, depending on individual perceptions of digital infrastructure and student learning outcomes.

Managerial Implications

The results of the research that has been conducted produce the following managerial implications:

1) For schools, it is recommended to continue improving digital infrastructure in schools, with a focus on providing adequate devices and improving internet connections, in order to create more interactive and engaging learning for students.
2) The government needs to pay more attention to providing digital infrastructure facilities in remote schools to reduce the existing educational gap.

Future Research

Based on the limitations of the research, it is suggested for future research as follows:

1) It is hoped that further research can delve deeper into other factors that can also influence student learning outcomes, as well as examine the long-term impact of digital infrastructure on students' academic development.
2) Further research could consider other factors that influence student learning outcomes, such as teaching characteristics, student motivation, and parental support.

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