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Digital Education for Primary School Children: Opportunities, Challenges, and Implementation Gaps in the Global Age of Technology †

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Abstract

This study aims to examine the implementation of digital education at SDN Cicurug Caringin and SDIT Nabawi, Sukabumi Regency, with a focus on opportunities, challenges, and gaps in the use of technology for learning at the elementary school level. Using a qualitative approach and a comparative case study design, this study explores the application of digital education in two different contexts, namely in rural areas (SDN Cicurug Caringin) and urban areas (SDIT Nabawi). Data were collected through in-depth interviews with four teachers, two principals, eight students, and four parents, as well as direct observation in both schools. The analysis techniques used are data reduction, data presentation, and conclusion drawing, with Miles and Huberman's interactive analysis procedures. The results of the study show that SDN Cicurug Caringin faces significant infrastructure constraints, such as a student-computer ratio of 1:15, limited internet connection, and low digital literacy of parents due to their simple socio-economic background. On the other hand, SDIT Nabawi has succeeded in utilizing digital platforms such as Let's Read to increase students' interest in reading, although it is limited by teaching time and lack of TPACK (Technological Pedagogical Content Knowledge) training for teachers. The main gaps found between the two schools are unequal access to technology, limited teacher capacity to integrate technology, and low parental support in assisting children in digital learning. This study provides empirical evidence that the success of digital education is highly dependent on adequate infrastructure, TPACK-based training for teachers, and parental involvement in digital literacy. The recommendations included infrastructure improvements, TPACK training for teachers, and the implementation of digital literacy workshops for parents to reduce disparities and improve learning outcomes.

Keywords: digital education; primary school; technological infrastructure; TPACK; parental digital literacy

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1. Introduction

Digital education has brought significant changes in the global education landscape, creating opportunities to improve access and quality of learning through technology, such as online platforms, interactive applications, and innovative methods such as flipped classrooms, blended learning, and digital gamification [1]. At this level, the integration of

technology not only has the potential to increase student motivation and engagement, but it can also strengthen 21st-century skills, such as critical thinking and creativity [2]. However, the implementation of digital education in Indonesia, especially in areas with limited infrastructure, faces major challenges that affect the effectiveness of its implementation.

Gaps in access to technology and the readiness of educators are the main obstacles in implementing digital education in Indonesia. This research focuses on two elementary schools in Sukabumi Regency, namely SDN Cicurug Caringin, which represents a rural context with limited infrastructure, and SDIT Nabawi, which reflects an urban environment with more adequate facilities. These two schools were chosen because of their contextual differences that can reflect the broader reality in Indonesia, providing an overview of the challenges and opportunities that exist in the implementation of digital education.

However, although many studies address these infrastructure gaps, few reveal how factors such as teacher capacity and parental involvement interact in the specific context of primary schools. In addition, the wider gap related to the low digital literacy of parents and the lack of teacher training in technological–pedagogical approaches such as TPACK (Technological Pedagogical Content Knowledge) also affects the quality of digital education implementation [3]. This research gap is significant, because without a deeper understanding of the interactions between these factors, efforts to improve digital education risk being ineffective.

This research aims to fill the research gap by exploring the impact of infrastructure gaps, teacher capacity, and parental involvement on the implementation of digital education in the two schools. Furthermore, this study aims to identify best practices that can be implemented in environments with limited resources. To guide the analysis, this study adopts two complementary theoretical frameworks: the digital literacy framework [4], used to measure the readiness of students and teachers to utilize learning technology, and the TAM technology adoption model [5], which focuses on the factors of technology acceptance, such as the perception of ease of use and benefits, that affect the level of technology adoption by teachers, students, and parents. By integrating these two frameworks, the research explores not only the technical aspects of digital education but also the social and human dimensions that influence its success.

The approach used in this study allows for a more comprehensive mapping of existing challenges and opportunities and offers new insights into how digital education can be optimized in both resource-constrained and inadequate environments. It is hoped that the results of this research can be the basis for local education policies that are more inclusive and responsive to the needs of elementary school students in the era of global technology.

2. Research Methods

This study uses a qualitative approach with a comparative case study design to explore the implementation of digital education at SDN Cicurug Caringin and SDIT Nabawi, two elementary schools in Sukabumi Regency that represent rural and urban contexts. This approach was chosen to gain an in-depth understanding of the opportunities, challenges, and gaps in the use of educational technology by comparing the two schools. The main objective of this study is to analyze the factors influencing the implementation of digital education in both schools as well as identify strategies that can reduce the gap between the two.

This study involved 18 participants, consisting of four teachers (2 from SDN Cicurug Caringin and 2 from SDIT Nabawi) who were selected based on a minimum of two years of experience in integrating technology in learning. In addition, 2 principals (one from each school), who play the role of key decision-makers in the school's digital program, are also involved. This study also involved 8 students (4 from each school) who were randomly

selected from grades 4 to 6 and actively used technology in learning. Finally, 4 parents (2 from each school) who were selected based on their involvement in assisting children in digital learning were also included.

This study uses three main techniques in data collection, namely in-depth interviews, direct observation, and document analysis. In-depth interviews were conducted in a semi-structured manner with a duration of 30–45 min per session, aimed at exploring the experiences, challenges, and impact of digital education on student learning. Interview questions cover topics related to infrastructure, teacher capacity, and the role of parents in supporting digital learning. In addition, direct observation was carried out for 12 h, with 6 h in each school divided into three sessions (2 h per session) over two weeks. The focus of observation was on classrooms that use technology, such as the use of computer labs or digital learning platforms such as Let's Read, as well as interactions between teachers and students, device use, and student participation levels. Finally, document analysis was carried out by analyzing the curriculum, lesson schedules, and digital program reports in both schools to complement the data obtained from interviews and observations.

The selection of SDN Cicurug Caringin and SDIT Nabawi is based on three main criteria. First, there is a geographical and socio-economic contrast between the two, where SDN Cicurug Caringin represents a rural school with limited infrastructure, while SDIT Nabawi is located in an urban area with more adequate facilities. Second, these two schools have sought to integrate digital education, albeit with different scales and approaches. Third, easy access to observation and interviews, as well as the readiness of the school to be involved in research, are further reasons for their selection.

The collected data was then analyzed using interactive analysis techniques according to [6], which consisted of three stages. At the data reduction stage, relevant information from interview transcripts and observation notes is filtered to identify opportunities, challenges, and gaps in the implementation of digital education. Furthermore, at the data presentation stage, the data that has been reduced is grouped into key themes such as infrastructure, teacher capacity, and parental involvement through an open coding process. At the conclusion drawing stage, the researcher identified patterns and relationships between themes that emerged from the data collected. The coding process was performed manually by two researchers to ensure consistency, starting with rereading the interview transcript and grouping it into thematic categories.

To ensure validity and reliability, this study applied source triangulation by comparing data from interviews, observations, and document analysis to ensure the consistency of findings. For example, complaints about infrastructure submitted by teachers will be validated by direct observation of the condition of computer laboratories in schools. In addition, interview transcripts will be reviewed by participants to verify the accuracy of the data obtained, and the initial analysis process will be reviewed by two independent researchers to reduce interpretation bias. All documentation of data collection and analysis procedures will be kept in detail so that this study can be replicated by other researchers to ensure the reliability of the findings.

This research method is designed to achieve three main objectives. First, to evaluate the effectiveness of digital education programs using interviews with teachers and students to measure the effectiveness of programs based on direct perceptions of motivation and understanding of the material. Second, to identify supporting and inhibiting factors, through observation and interviews with principals and parents, to identify existing opportunities and challenges, such as the use of the Let's Read platform and low device ratios. Third, to propose evidence-based recommendations through thematic analysis to uncover gaps such as infrastructure disparities or low digital literacy of parents, which will be the basis for evidence-based recommendations in the development of digital education.

3. Results and Discussion

This study examined the implementation of digital education at two elementary schools—SDN Cicurug Caringin and SDIT Nabawi—through interviews, observations, and document analysis. The key findings are organized into four thematic areas:

1. Teacher Capacity in Digital Education
   At SDN Cicurug Caringin, instruction primarily focuses on basic technical skills, such as computer operation, without an emphasis on digital ethics education. Technology use is generally limited to simple presentations. In contrast, SDIT Nabawi provides comprehensive training that covers both technical skills and crucial digital citizenship concepts, including plagiarism prevention, especially when utilizing platforms like Let's Read.
2. Program Effectiveness Evaluation
   SDN Cicurug Caringin reported that only 20% of students showed academic improvement with computer use, a challenge largely attributed to infrastructure limitations. SDIT Nabawi demonstrated stronger outcomes, with 60% of students showing improved comprehension and achieving 10–15% higher assignment scores through consistent usage of the Let's Read platform.
3. Implementation Challenges
   SDN Cicurug Caringin struggles with several key issues: inadequate infrastructure, reflected in a 1:15 student-to-computer ratio; unstable internet connectivity; and low parental involvement, with only 10% parental support for digital education initiatives. While SDIT Nabawi maintains better resources (a 1:6.7 student-to-computer ratio), it faces its own set of challenges, including ongoing equipment maintenance issues and teacher time constraints for effective digital program management.
4. Future Development Strategies
   Both schools expressed keen interest in adopting online project-based learning to enhance student collaboration. Specific proposals for future development include, for SDN Cicurug Caringin, the acquisition of 10 additional computers, and for SDIT Nabawi, weekly teacher training sessions and digital literacy workshops specifically for parents.

Based on the findings, this section analyzes the implications in four themes, connects them to data and literature, and offers evidence-based solutions.

1. The Role of Teachers in Digital Security and Ethics. This finding is in line with [7], who emphasizes the importance of the role of teachers in teaching digital ethics. At SDN Cicurug Caringin, the lack of teacher training on digital ethics reflects the limited resources and training in rural areas, as explained by [8]. On the contrary, at SDIT Nabawi, a proactive approach in educating students about digital ethics shows the importance of special training for teachers.
2. The Impact of Digital Programs on Academic Development. An evaluation of the effectiveness of the digital program showed different outcomes between the two schools. At SDN Cicurug Caringin, only a few students showed an increase in grades, while at SDIT Nabawi, more students showed a significant increase. This shows that the effectiveness of the program depends on the quality and frequency of technology use, according to the findings of [9].
3. Implementation Challenges and Gaps SDN Cicurug Caringin faces a huge gap in terms of infrastructure and parental involvement, which has an impact on the success of digital education. At SDIT Nabawi, even though the facilities are better, challenges still arise in terms of limited teachers' time and device damage. These findings

support [10], who state that effective collaboration between schools and parents requires maintained resources and more intense communication.

4. Evidence-Based Development Strategy Some evidence-based strategies that can be applied to improve the implementation of digital education include:
   - Infrastructure: SDN Cicurug Caringin requires additional computers to achieve a 1:5 ratio, while SDIT Nabawi requires regular maintenance of devices.
   - Teacher Training: The weekly TPACK-based training at SDIT Nabawi will improve the integration of technology and digital ethics.
   - Parent Collaboration: A monthly digital literacy workshop suggested by parents at SDIT Nabawi can increase parental involvement at SDN Cicurug Caringin from 10% to 50%.
   - Periodic Evaluations: Evaluation each semester of improving students' grades and understanding can help adjust strategies and ensure the success of the program.

The implementation of digital education at SDN Cicurug Caringin and SDIT Nabawi reflects different structural challenges, depending on the location and resources available. The success of digital education does not depend only on the technology itself but on the synergy between infrastructure, teacher capacity, and parental support. Effective collaboration requires concrete steps, such as training for teachers and regular communication with parents, to ensure the relevance and success of programs in the digital age. The data can be seen in the Table 1 below.

Table 1. Evaluation of Digital Education Programs.

Aspects	Cicurug Caringin	SDIT Nabawi
Infrastructure Availability	Technological facilities are inadequate; there is a high dependence on external resources.	The facilities are quite good; some shortcomings still exist.
Digital Learning Program	Limited; difficulties in implementing ANBK.	Using the Let's Read platform; the program is going well.
Parent Involvement	Less than optimal; parents are busy with work.	Encouraged to help with digital story reviews.
The Role of the Teacher	Limitations in the integration of technology into the curriculum.	Educate students about digital security and ethics.
Program Evaluation	Evaluation is based on student academic development.	Evaluations are conducted to understand the effectiveness of the program.
Development Strategy	Infrastructure investment and teacher training.	Collaboration with parents and the community.

4. Conclusions

This study explores the implementation of digital education at SDN Cicurug Caringin and SDIT Nabawi, with a focus on identifying opportunities, challenges, and gaps in the use of technology at the elementary school level. Key findings show that SDN Cicurug Caringin faces significant obstacles in terms of infrastructure, with a low student–computer ratio (1:15), weak internet connections, and low parental involvement (only 10%). On the other hand, SDIT Nabawi has succeeded in increasing students' interest in reading through the Let's Read platform, supported by more adequate facilities (ratio of 1:6.7) and higher parental involvement (50%). These findings provide empirical evidence that the success of digital education depends not only on access to technology but also on effective interaction between adequate infrastructure, the capacity of TPACK-trained teachers, and strong collaboration with parents.

This research also reveals contextual challenges that deepen the gap in digital education implementation, such as parents' socio-economic backgrounds that affect their digital literacy, as well as the limited time available for teachers to optimally manage digital education programs. Based on these findings, some more in-depth recommendations were

proposed. First, for SDN Cicurug Caringin, significant investments need to be made in infrastructure, such as adding 10 computers to achieve a 1:5 ratio and increasing internet speed to a minimum of 10 Mbps, to ensure more equitable access to technology. Second, weekly TPACK training for teachers in both schools is essential, with a focus on the integration of technology in teaching and understanding of digital ethics, which should be carried out with a minimum duration of 2 h per session to ensure adequate skills. Third, to increase parental involvement, it is recommended to hold monthly digital literacy workshops at SDN Cicurug Caringin, with the aim of increasing parental involvement from 10% to 50%. This workshop should include material on the basic use of the device and how parents can more effectively supervise the content their children access.

While these findings provide valuable insights, the study has limitations, such as a small sample size (only 18 participants), as well as a reliance on qualitative data, which limits the ability to generalize these findings to a wider population. The limited duration of observation (12 h) may also not be sufficient to capture seasonal variations in the implementation of digital programs in schools. Therefore, for follow-up research, it is recommended to conduct a longitudinal study to evaluate the long-term impact of digital education on students' academic achievement and digital literacy. In addition, quantitative research with a larger sample is needed to measure the statistical relationship between infrastructure, parental engagement, and student learning outcomes. Finally, the exploration of comparisons between districts or regions with different digital education policies can provide more in-depth insights into the influence of local policies on the success of digital education implementation at the elementary school level.

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