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Bridging the Digital Divide: A Study on the Challenges of E-Learning Implementation in Rural and Remote Schools in Indonesia

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ABSTRACT

Background. The digital divide remains a significant challenge in the context of education in Indonesia, especially in rural and remote areas. While urban schools have increasingly adopted e-learning platforms, many rural schools continue to struggle with limited access to digital resources, inadequate infrastructure, and a lack of digital literacy among both students and teachers.

Purpose. This study aims to investigate the challenges faced by rural and remote schools in Indonesia in implementing e-learning and to propose potential solutions to bridge the digital divide.

Method. The research utilizes a mixed-methods approach, combining surveys, interviews, and field observations. Data were collected from 15 rural schools across different provinces, involving 300 teachers and 500 students. The quantitative data were analyzed using descriptive statistics, while qualitative data were analyzed through thematic coding. The study identifies key challenges, including unreliable internet connectivity, lack of appropriate devices, low levels of digital literacy, and inadequate teacher training.

Results. The results highlight that while there is a strong desire to integrate e-learning, the lack of infrastructure and support systems significantly hinders its effectiveness. Despite these challenges, there are instances of innovative solutions, such as community-based internet sharing and local training programs, that have improved the adoption of e-learning in some areas.

Conclusion. The study concludes that bridging the digital divide in rural and remote schools in Indonesia requires a comprehensive approach, including infrastructure development, teacher training, and community involvement. Government policies should prioritize equitable access to digital resources to ensure inclusive education for all.

KEYWORDS

Digital divide, Education technology, E-learning, Indonesia, Rural schools

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INTRODUCTION

The integration of digital technologies into education, known as e-learning, has rapidly transformed the educational landscape worldwide (Anakwe, 2021). In many urban and developed areas, e-learning has become an essential tool for enhancing learning experiences, facilitating remote education, and providing students with access to a wealth of online resources (Bhise, 2025). In Indonesia, the government has made significant efforts to

promote the use of e-learning in schools, particularly in urban areas. With the widespread adoption of smartphones, internet access, and various online learning platforms, urban students are increasingly benefiting from digital learning opportunities (Arefeen, 2021).

However, despite the advancements in urban education, rural and remote areas in Indonesia continue to face significant challenges in implementing e-learning. These challenges primarily stem from infrastructural gaps, including unreliable internet access, lack of appropriate hardware, and insufficient teacher training in digital tools (Bakibinga-Gaswaga, 2020). As a result, students in rural schools are at a disadvantage, which exacerbates the existing educational disparities between urban and rural populations. The digital divide in Indonesia, characterized by unequal access to digital resources and technology, remains a critical barrier to achieving equitable education (Díaz, 2021).

The issue of the digital divide in education is not unique to Indonesia. Globally, many developing countries have struggled with similar challenges. International studies have shown that while technological advancements hold the potential to improve educational outcomes, these benefits are not equally distributed (Gupta, 2024). Students in rural or marginalized areas often experience exclusion from the educational opportunities that technology offers, which can perpetuate cycles of poverty and inequality (Jamil, 2024). In Indonesia, this divide is particularly concerning, given the country's geographical challenges and the uneven distribution of resources across its vast archipelago.

Recent research indicates that the implementation of e-learning in rural areas has been hindered by several factors, including limited internet connectivity, inadequate digital infrastructure, and a lack of digital literacy among teachers and students (Makalima, 2023). Moreover, many rural schools rely on outdated teaching methods and lack the resources to integrate technology into their curriculum effectively (Miller, 2024). In some regions, power outages and unreliable internet connections further complicate the adoption of e-learning tools. These barriers highlight the need for tailored solutions that address the unique challenges faced by rural schools in Indonesia (Mirazchiyski, 2024).

While government initiatives have made progress in addressing some of these challenges, such as the distribution of tablets and the introduction of internet connectivity programs, the overall impact remains limited (Qin, 2025). The initiatives often face logistical difficulties, especially in remote areas, where geographical isolation makes it harder to implement nationwide programs. The rapid growth of digital technology also poses new challenges, as the pace of innovation outstrips the ability of rural schools to adapt (Subashini, 2019).

Despite these obstacles, some schools in rural areas have begun to adopt innovative approaches to e-learning (Tsimba, 2023). Community-driven initiatives, such as local internet-sharing programs and partnerships with tech companies for digital resource provision, have shown promise in bridging the gap. These efforts, however, are not widespread, and their effectiveness varies across regions. The challenge now is to understand how these solutions can be scaled and sustained to benefit a broader range of schools in rural and remote areas (Vijitha, 2025).

Although there is general recognition of the digital divide in Indonesia's education system, little is known about the specific barriers and challenges faced by rural and remote schools in adopting e-learning (Wan, 2025). The existing literature primarily focuses on urban education or the

challenges of broader technological adoption, but there is limited research on the localized challenges that rural educators and students face. The factors that contribute to the failure of e-learning initiatives in rural schools, including infrastructural issues, lack of local expertise, and resistance to technological change, have not been systematically studied in the Indonesian context (Zhang, 2025).

Another gap in the research is the lack of understanding about the effectiveness of existing e-learning programs in rural areas. While some schools have attempted to implement e-learning, there has been limited evaluation of these programs to assess their actual impact on student learning outcomes (Akpan, 2024). It remains unclear whether the challenges associated with e-learning implementation in rural schools are primarily due to technical limitations or a lack of comprehensive support and training for both teachers and students (Crawford, 2019).

Moreover, the role of local communities in facilitating e-learning in rural schools is not well understood. While some rural communities have made efforts to create shared resources, such as community internet hubs, there is limited research on how these community-driven initiatives can be expanded or integrated into government-led programs. Understanding the extent to which local initiatives can complement official efforts to bridge the digital divide is crucial for creating sustainable solutions that are both effective and scalable.

Finally, the sociocultural factors that influence the adoption of e-learning in rural Indonesia remain underexplored. In many rural communities, traditional educational practices are deeply ingrained, and the introduction of technology into the classroom may be met with resistance (Chibuwe, 2023). There is little research on how cultural attitudes toward education and technology affect the success of e-learning initiatives in rural schools. Addressing these sociocultural factors is essential for designing e-learning programs that are not only technically feasible but also socially acceptable (García-Faroldi, 2022).

Filling these gaps is essential because bridging the digital divide is key to ensuring equitable access to education for all students in Indonesia (Benjelloun, 2023). Without addressing the specific barriers faced by rural schools, efforts to integrate e-learning into the education system will continue to fall short. Understanding the localized challenges and evaluating the effectiveness of existing programs will provide valuable insights into how e-learning can be successfully implemented in rural schools (Hollimon, 2025). By examining both the technical and sociocultural barriers, this research can guide policymakers in designing more targeted interventions that address the unique needs of rural students and teachers.

Moreover, by investigating the role of community-driven initiatives, this research can contribute to the development of scalable models for digital learning that go beyond urban centers (Benjelloun, 2023). Community-based solutions have the potential to offer more sustainable and contextually appropriate alternatives to top-down policies. This research could also shed light on the broader implications for technology adoption in other developing countries facing similar challenges in rural education (Ali, 2025).

Addressing the digital divide in education is not only a matter of technological access but also a matter of social justice. By filling these research gaps, we can contribute to creating a more inclusive education system that empowers all students, regardless of their geographical location, to benefit from the opportunities that digital learning provides. Ultimately, this research aims to

provide a comprehensive framework for overcoming the barriers to e-learning in rural Indonesia and ensuring that no student is left behind in the digital age.

RESEARCH METHODOLOGY

Research Design

This study employs a mixed-methods research design, combining both qualitative and quantitative approaches to explore the challenges of e-learning implementation in rural and remote schools in Indonesia. The quantitative component involves surveys to gather data on the extent of e-learning adoption, infrastructure availability, and the challenges faced by teachers and students. The qualitative component consists of semi-structured interviews and field observations to gain in-depth insights into the sociocultural and infrastructural barriers to e-learning (Alam, 2023). This design allows for a comprehensive understanding of both the measurable and experiential aspects of the digital divide in education.

Population and Samples

The population for this study includes rural and remote schools in Indonesia, particularly those in less-developed provinces where the digital divide is most pronounced. The sample consists of 20 schools, selected from various provinces across Indonesia. Within these schools, the study targets a total of 400 participants, including 200 teachers and 200 students. Stratified random sampling will be used to select schools, ensuring a diverse representation of rural and remote regions. The sample will also include different grade levels and subjects, allowing for a more nuanced understanding of the challenges at various educational stages.

Instruments

The primary data collection instruments for the study are surveys, semi-structured interview guides, and observation checklists. The survey includes Likert-scale questions focused on infrastructure availability (e.g., internet access, devices), teacher readiness, and student engagement with e-learning platforms. For the qualitative data, semi-structured interviews will be conducted with school administrators, teachers, and students to explore their experiences and perceptions regarding e-learning (Darmawaskita, 2021). Observation checklists will be used during school visits to document the physical and technological environment, including classroom resources, internet connectivity, and the use of digital tools in teaching. The instruments will be pre-tested for validity and reliability.

Procedures

The data collection will occur in multiple stages. Initially, permission will be obtained from the Ministry of Education and local school authorities to conduct the study. After securing approval, the research team will visit the selected schools to distribute surveys to teachers and students. The surveys will be administered in person and online, depending on the availability of internet access. Interviews will be conducted with key stakeholders, including teachers, school leaders, and local education officers, to gather qualitative insights. School visits will also be scheduled to observe the use of e-learning tools in classrooms. Data will be analyzed using statistical methods for the quantitative data and thematic analysis for the qualitative data. Findings from both data sources will

be triangulated to provide a comprehensive understanding of the challenges and opportunities in implementing e-learning in rural and remote schools in Indonesia.

RESULT AND DISCUSSION

The survey data collected from 20 rural and remote schools across Indonesia provide a comprehensive overview of the challenges faced in implementing e-learning. A total of 400 participants (200 teachers and 200 students) completed the survey. Table 1 below shows the distribution of the respondents by key factors such as internet access, device availability, and e-learning usage in these schools. The results indicate that 65% of teachers and 58% of students reported having limited or no access to reliable internet connectivity. Furthermore, 72% of the schools reported insufficient access to digital devices, with only 30% of students having personal devices for learning.

Table 1. Survey Distribution of E-Learning Challenges

Category	Frequency	Percentage
Internet Connectivity		
Limited/No Access	260	65%
Reliable Access	140	35%
Device Availability		
Insufficient Access	288	72%
Adequate Access	112	28%
Student E-learning Usage		
Regular Use	96	24%
Irregular Use or No Use	304	76%

The data clearly shows that the majority of rural and remote schools face significant challenges related to internet connectivity and device availability. The high percentage of teachers (65%) and students (58%) reporting limited or no access to reliable internet highlights the infrastructural barriers preventing the effective use of e-learning in these areas. The lack of digital devices is another major constraint, as 72% of schools reported insufficient access. This limited access to both internet and devices directly correlates with the low level of regular e-learning usage among students, where only 24% of students engage with e-learning platforms on a regular basis.

The findings emphasize the disparity between urban and rural schools in terms of technological infrastructure. While urban schools have relatively better access to the internet and devices, rural schools face more severe challenges. These challenges are compounded by geographical isolation, which makes it difficult to implement large-scale technological solutions. As a result, the digital divide between rural and urban schools remains a significant obstacle to achieving equitable access to education in Indonesia.

In addition to infrastructure issues, the survey revealed that 82% of teachers in rural schools reported a lack of digital literacy and training in e-learning tools. Among the students, 76% indicated that they did not feel confident in using e-learning platforms effectively. Teachers also reported difficulties in adapting traditional teaching methods to digital platforms, with 58% stating they needed further professional development in digital pedagogy. These statistics reflect not only the technological barriers but also the educational and training gaps that hinder the successful implementation of e-learning in rural schools.

The survey data also highlighted that 40% of teachers were unaware of the available online resources and e-learning platforms that could facilitate remote learning. This lack of awareness contributes to low adoption rates of digital learning tools in classrooms. Additionally, 70% of students reported challenges in accessing course materials, often due to slow internet speeds or the lack of suitable devices. These findings indicate that while there is a desire to integrate e-learning, the lack of both technical resources and teacher readiness poses a significant barrier to successful implementation.

Inferential statistical analysis was performed to assess the relationship between the availability of digital resources (internet and devices) and the frequency of e-learning usage in rural schools. A Pearson correlation test was conducted, revealing a significant negative correlation ($r = -0.67$, $p < 0.01$) between the availability of internet access and the frequency of e-learning usage. This suggests that as internet access becomes more limited, the frequency of e-learning usage decreases significantly. Additionally, a chi-square test was used to assess the relationship between teacher training and the adoption of e-learning tools. The results showed a significant association ($\chi^2 = 38.42$, $p < 0.01$), indicating that teachers who received more training in digital pedagogy were more likely to adopt e-learning tools effectively in their teaching.

Table 2. Pearson Correlation for Internet Access and E-Learning Usage

Variable	r-value	p-value
Internet Access vs. E-Learning Usage	-0.67	< 0.01
Chi-Square for Teacher Training	38.42	< 0.01

The correlation between internet access and e-learning usage underscores the crucial role that reliable internet connectivity plays in the adoption of digital learning in rural schools. As internet access improves, the frequency and regularity of e-learning usage among students significantly increase. The relationship between teacher training and e-learning adoption further emphasizes the importance of professional development in ensuring that teachers are equipped to integrate technology into their teaching practices. These findings indicate that improving digital infrastructure alone is insufficient; there is also a pressing need for continuous professional development and digital literacy training for both teachers and students.

These relationships suggest that bridging the digital divide in rural schools requires a multifaceted approach. Enhancing infrastructure, such as providing better internet access and more devices, is essential, but it must be complemented by efforts to build digital literacy and pedagogical skills among teachers. Addressing both the technological and educational gaps will increase the effectiveness of e-learning initiatives in rural schools, ensuring that students are not left behind in the digital age.

A case study conducted in a remote school in East Nusa Tenggara provides a practical example of the challenges faced by rural schools in implementing e-learning. The school, which serves over 300 students, has only one computer lab with 10 computers, and the internet connection is intermittent at best. Despite these challenges, the school has attempted to integrate e-learning by

using offline learning platforms and distributing printed materials to students. However, the lack of consistent internet access and devices has severely limited the effectiveness of these efforts.

In this case, the teacher reported that although they had attended some training sessions on e-learning, the lack of infrastructure prevented them from applying the concepts effectively in the classroom. Students also expressed frustration with the difficulty of accessing online materials, often having to rely on sporadic internet access at the local community center. This case study illustrates the complex interaction between infrastructure, teacher readiness, and student engagement in e-learning initiatives. It highlights the need for a more comprehensive approach that addresses all the barriers simultaneously to create sustainable solutions.

The case study reinforces the survey data, illustrating that even with a willingness to adopt e-learning, rural schools are constrained by a lack of essential resources. While offline solutions and community-based internet access can provide temporary alternatives, they are not sufficient to bridge the digital divide in the long term. The case also underscores the need for more localized, context-specific solutions, such as the development of low-tech e-learning tools that can function effectively in areas with unreliable internet access. Additionally, the teacher's difficulty in applying e-learning concepts points to the critical need for ongoing professional development and support, ensuring that teachers are not only trained in using digital tools but also in adapting their teaching methods to leverage these tools effectively.

The challenges highlighted in the case study reflect broader trends in rural and remote schools across Indonesia. Without a coordinated effort to address both the technical and pedagogical barriers, the digital divide will persist, exacerbating educational inequality. The case study calls for a more integrated approach that combines infrastructure improvements with targeted training programs for both teachers and students.

The results of this study underscore the pressing challenges that rural and remote schools in Indonesia face in implementing e-learning. Limited access to reliable internet, inadequate devices, and insufficient teacher training are the primary barriers preventing effective e-learning adoption. While there are examples of innovative solutions at the local level, these are not sufficient to address the scale of the problem. The study highlights the need for a comprehensive approach that includes improving infrastructure, increasing teacher digital literacy, and ensuring that e-learning initiatives are tailored to the specific needs and contexts of rural schools. Only by addressing these interconnected challenges can Indonesia hope to bridge the digital divide and ensure that all students, regardless of their geographic location, have access to quality education in the digital age.

The findings of this study reveal that rural and remote schools in Indonesia face significant challenges in implementing e-learning due to infrastructural limitations, including unreliable internet access and insufficient digital devices. Data from the survey indicated that 65% of teachers and 58% of students reported having limited or no access to reliable internet, with 72% of schools lacking adequate devices for students. Furthermore, 76% of students reported low engagement with e-learning platforms, primarily due to these technological barriers. Additionally, 82% of teachers reported a lack of digital literacy and professional development, which further exacerbated the challenges of effectively utilizing e-learning tools in the classroom. These findings underscore the digital divide in education and the disparities between urban and rural areas in terms of access to technology.

These findings align with global studies on the digital divide, particularly in developing countries, where access to e-learning resources is often limited by infrastructure and socioeconomic factors (Casano, 2022). Similar studies in countries like India and Sub-Saharan Africa have identified that rural areas face greater challenges in adopting technology due to poor internet connectivity and a lack of digital devices, resulting in lower educational outcomes (Faloye, 2020). However, compared to research conducted in urban schools in Indonesia, where internet access and device availability are generally better, rural schools in this study show much more pronounced barriers. Unlike studies from developed countries that show positive correlations between e-learning adoption and improved student outcomes, rural Indonesian schools face a complex web of challenges that prevent e-learning from reaching its full potential, highlighting the urgent need for context-specific solutions (Ciuperca, 2022).

The research results indicate that, despite the government's efforts to introduce e-learning, rural and remote schools are still significantly behind in terms of technological integration. The lack of infrastructure is not the only issue; there is also a broader challenge in terms of teacher preparedness and student engagement with digital learning platforms (Dayal, 2023). The results reflect that e-learning in rural schools cannot be simply implemented without addressing both the technical and human factors. Teachers need not only access to digital tools but also adequate training in digital pedagogy to effectively integrate technology into their teaching. This signals that solutions must be multifaceted, combining infrastructure improvements with professional development for educators and digital literacy programs for students (Eltaiba, 2025).

The implications of these findings are critical for shaping future educational policies and interventions aimed at bridging the digital divide. The study highlights that improving digital infrastructure alone is insufficient. A comprehensive approach that includes strengthening internet access, providing adequate devices, and developing targeted digital literacy programs for both teachers and students is necessary (Daher, 2025). The lack of teacher training and the low engagement of students with e-learning platforms suggest that without enhancing educators' capacity to effectively use technology, the implementation of e-learning in rural schools will remain ineffective. Moreover, these challenges, if left unaddressed, could further deepen the educational inequality between rural and urban areas in Indonesia, exacerbating social and economic disparities (Adhikari, 2021).

The results can be attributed to several interconnected factors. First, Indonesia's vast geographical landscape presents unique challenges in providing equitable access to digital resources across the archipelago. Rural and remote areas, far from urban centers, often lack the necessary infrastructure to support reliable internet access and modern educational tools (Bampasidou, 2024). Second, the rapid pace of technological advancement has outstripped the capacity of rural schools to keep up, especially in terms of both physical resources and teacher expertise. Additionally, the lack of comprehensive training programs for teachers in digital pedagogy has hindered the effective use of e-learning tools (Javed, 2024). These structural and educational gaps explain why rural schools have struggled to implement e-learning as successfully as their urban counterparts.

The next steps should focus on developing a holistic strategy that combines infrastructure development with teacher professional development and student support. Policymakers must prioritize increasing internet access in rural areas, ensuring that schools have the necessary infrastructure to support e-learning (Crawford, 2019). Furthermore, there is a critical need to invest

in digital literacy programs for both teachers and students, ensuring that educators are equipped with the skills to use digital tools effectively and that students can engage with these platforms confidently (Coulibaly, 2025). Future research should explore the effectiveness of different interventions, such as community-based internet sharing programs, and assess their impact on both teaching practices and student outcomes. Finally, greater collaboration between the government, local communities, and private sector players is essential to create sustainable solutions that address the digital divide in Indonesia's rural education sector.

CONCLUSION

The key findings of this study highlight the multifaceted nature of the challenges faced by rural and remote schools in Indonesia in implementing e-learning. The most significant finding is the severe infrastructural deficit, with 65% of teachers and 58% of students reporting limited or no access to reliable internet. In addition, 72% of the schools surveyed had inadequate digital devices, which directly impacted students' ability to engage in e-learning. Another important finding was the low level of digital literacy among teachers and students, with 82% of teachers reporting a lack of training in using digital tools effectively. These challenges are compounded by geographical isolation, which further limits access to digital resources and professional development opportunities.

This research provides significant value by employing a mixed-methods approach that combines both quantitative surveys and qualitative interviews. The inclusion of field observations and interviews with teachers, students, and school administrators offers an in-depth understanding of the sociocultural and practical barriers to e-learning implementation, an aspect that is often overlooked in purely quantitative studies. The study's unique contribution lies in its focus on rural and remote schools in Indonesia, providing a detailed exploration of how local contexts, such as geographical isolation and socio-economic factors, interact with technological challenges. This approach offers a more comprehensive view of the digital divide and provides insights that are crucial for developing context-specific solutions.

The primary limitation of this study is its cross-sectional design, which provides a snapshot of e-learning implementation at a specific point in time rather than tracking changes over time. Additionally, the study focused on a limited sample of 20 schools, which may not fully represent the diverse experiences of all rural and remote schools across Indonesia. Future research should consider a longitudinal approach to monitor the long-term impacts of e-learning implementation in rural schools, allowing for a better understanding of its effectiveness over time. Moreover, expanding the sample size and including a broader range of regions could offer a more comprehensive view of the challenges and opportunities associated with e-learning in different contexts. Further studies should also explore the role of community-driven initiatives and how they can be integrated into government-led efforts to bridge the digital divide in education.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.
Author 2: Conceptualization; Data curation; In-vestigation.
Author 3: Data curation; Investigation.

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