Digitalization and Education Equity in Remote Areas: Challenges and Strategic Solutions

Muslimin* & RA Indrawati

Public Administration Study Program, Faculty of Social Humanities,
Universitas Cahaya Prima, Indonesia

*Corresponding Email: socialscience897@gmail.com

Abstract

The COVID-19 pandemic has accelerated digitalization in the education sector, highlighting disparities in technology access, particularly in remote areas like Bone Regency, South Sulawesi. This study explores the impact of digitalization on equitable access to education in this region and identifies challenges and potential solutions to bridge the digital divide. The study used ethnographic methods to gather insights from selected students, teachers, academics, and parents. Findings reveal that limited digital infrastructure, lack of technology skills, and economic disparities are major barriers to digital education in Bone Regency. Social norms and gender roles further affect students' ability to use technology effectively, particularly for female students. Initiatives such as enhancing teacher training in digital skills, partnering with the private sector for infrastructure support, and implementing flexible hybrid learning models are identified as possible solutions. This study contributes to ongoing discussions about digital equity in education, providing actionable recommendations for policymakers to expand inclusive digital education access in remote areas.

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INTRODUCTION

The COVID-19 pandemic has accelerated the pace of digitalization in education, forcing educational institutions to shift from face-to-face to distance or online learning. Bone Regency, located in South Sulawesi with an area of approximately 4,559 km^2, is where most of the population lives in rural areas with limited access to digital infrastructure (Sari & Hawariah, 2021). The district has 27 sub-districts and more than 300 villages, but only a small percentage have stable internet access, especially in sub-district centers or more developed villages. (Awaluddin A et al., 2019). This challenge further exposes the digital divide between urban and rural areas and between the better-off and the less well-off.

Before the pandemic, education in Bone Regency was largely conventional, with most rural schools needing to be equipped with educational technology tools such as computers or adequate internet access. According to data from Bone Regency's Central Bureau of Statistics (BPS) in 2020, only around 40% of households in the region had internet access. Of these, only a small proportion had strong internet connections to support online learning (Nurman et al., 2022). This data aligns with a BPS report showing that digital device ownership in rural Bone is still low, with more than 60% of students not having a laptop or tablet to participate in online learning.

This further exacerbates the inequality in access to education between urban and rural students during the pandemic. Students in remote areas are often forced to rely on mobile phones with weak signals to attend online classes, and some even have to walk to certain points to get internet signals. This phenomenon occurs in remote sub-districts such as Tellu Limpoe, Bengo, and Bontocani, where internet networks are unavailable. Teachers in these areas also face similar constraints, with limited access to training and resources that can help them adapt teaching methods to digital formats. Many do not have adequate digital literacy, which is a serious obstacle to providing quality education.

Bridging the digital divide in areas like Bone Regency requires comprehensive interventions. The local government and the Ministry of Education and Culture need to step up efforts to provide internet access and digital devices in rural schools. While helpful, some existing programs, such as the central government's 'Internet Quota Assistance,' need to adequately address the fundamental problem of the absence of digital infrastructure in many remote areas. In addition, the government needs to invest in teacher capacity building through training programs that focus on digital literacy and technology-based pedagogy. This condition needs to be addressed immediately, as the quality of online learning relies heavily on teachers' ability to utilize educational technology well. Well-designed training programs, both online and face-to-face, can help teachers understand how to integrate digital tools into the learning process, thus providing quality education even in a remote format (Anggraini et al., 2024; Anita & Astuti, 2022; Muttaqien et al., 2023).

Collaboration between the government, private sector, and communities is also key to addressing this challenge. For example, several telecommunications companies in Indonesia have started CSR (Corporate Social Responsibility) programs that focus on improving internet access in remote areas. In Bone Regency, this program could be expanded by partnering with the local government to provide low-cost internet access for schools in rural areas. In addition, innovative funding models such as crowdfunding and community-based partnerships could be optimized to provide digital devices for underprivileged students.

Furthermore, introducing digital technology into education in remote areas can serve as a key driver to reducing regional economic disparities (Muttaqien et al., 2023; Tay & Loh, 2022). In many areas, such as Bone Regency, where the average household income is much lower than in urban areas, equal access to education can provide opportunities for young people to improve their quality of life. Digitization of education can open the door to distance learning, online courses, and certification opportunities that allow students from rural areas to gain new skills without moving to big cities (Aly, 2022; Rahmadi, 2023).

Bone Regency is characterized by its vast rural landscape, where limited internet access and lack of digital devices hinder students' participation in online learning. According to recent statistics, only a small percentage of households have stable internet access, which is mainly

concentrated in urban centers. Students in more remote villages often rely on mobile phones with weak signals, impacting their ability to fully engage in digital education.

Teachers in Bone Regency face their own challenges as they adapt to new technology-based teaching methods. Many have limited experience and training in digital tools, making it difficult to deliver interactive and effective online lessons. The lack of structured digital training programs for teachers compounds this issue, restricting their capacity to engage students and utilize online platforms to their full potential.

In addition to limited device availability and internet access, infrastructure challenges such as unstable network coverage and a lack of necessary equipment create significant barriers. Remote sub-districts like Tellu Limpoe, Bengo, and Bontocani face the most severe limitations, as they lack the infrastructure required to support consistent online learning. This situation underscores the need for comprehensive improvements in digital infrastructure in rural areas.

While various government and private initiatives aim to support digital learning in remote regions, substantial gaps remain. Briefly, this study suggests that expanding digital infrastructure, improving teacher training, and developing targeted support for students in rural areas could help bridge the digital divide. These recommendations are further explored in the discussion section, where specific strategies are outlined to promote equitable digital education in Bone Regency.

RESEARCH METHODS

This study employs a qualitative approach with an ethnographic design to deeply explore the impact of digitalization on access and quality of education in remote areas, particularly in Bone Regency. The ethnographic method was chosen to understand how students, teachers, academics, and parents interact with technology-based education within their cultural and social contexts. Additionally, to gain a more comprehensive view of the digital divide, the sample size was expanded to include local government officials and technology providers. These perspectives provide valuable insights into the infrastructure and policy dimensions of digital education in the region.

Sample Selection

The study involved 25 informants selected through purposive sampling, representing various groups: 10 local students, 5 teachers from rural schools, 3 academics experienced in rural education development, 2 parents supporting online learning, 3 local government officials, and 2 technology providers involved in infrastructure development in Bone. This diverse sample aims to capture a well-rounded view of the challenges and solutions associated with digitalization in education across different roles.

Data Collection

Data was collected using participant observation, in-depth interviews, and documentation. Observations were conducted in schools across several villages to directly observe technology infrastructure, student engagement, and teachers' digital skills in online learning. Semi-structured interviews allowed informants to share their experiences, challenges, and perceptions of digital learning in an open-ended format. Additional documents, such as local government policies on digitalization and statistics on digital infrastructure, were collected to contextualize the findings.

Ethical Considerations

Ethical protocols were strictly adhered to throughout the study. All informants provided informed consent before participation, ensuring they understood the purpose and scope of the research. Privacy and data confidentiality were prioritized, with measures taken to anonymize data and securely store interview transcripts and observation notes. These precautions were implemented to respect participants' privacy and uphold ethical standards in qualitative research.

Data Analysis

The data were analyzed using thematic analysis, where key themes related to digital access, educational challenges, and infrastructural issues were identified and categorized. Triangulation was conducted by comparing findings from interviews, observations, and documents to ensure

validity and reliability. This rigorous approach allows for a detailed examination of the complex factors influencing digital equity in Bone Regency's educational system.

RESULT

This study found that education digitalization in Bone district faces significant challenges stemming from infrastructure gaps, limited access, and digital skills. Based on in-depth interviews with 20 informants comprising students, teachers, academics, and parents, several key findings were highlighted.

Infrastructure

Limited digital infrastructure poses a critical barrier to the successful digitization of education in rural areas of the Bone Regency. The primary issue revolves around uneven internet access, where the majority of schools in remote regions are deprived of stable and sufficient internet connections. This problem is particularly concerning, given that the internet serves as the backbone of any online learning platform, facilitating real-time interaction, access to resources, and delivery of lessons. Without reliable internet access, both students and teachers struggle to meet the demands of digital education.

Interviews with local educators reveal that only a small number of schools in remote regions have access to the internet, and even then, the signal quality is often inconsistent. This poor signal disrupts various aspects of the learning process, creating significant obstacles for both teachers and students. Teachers, for example, frequently face challenges in downloading teaching materials or accessing essential online platforms, which hampers their ability to prepare and deliver lessons effectively. For students, the unstable connection means they are often unable to access the learning resources necessary to follow lessons or participate fully in online discussions. The digital divide becomes even more pronounced in interactive online learning environments, where active engagement is key to a student's academic success.

In particularly remote areas such as the sub-districts of Tellu Limpoe, Bengo, and Bontocani, the struggle for internet access is more extreme. Students in these regions are forced to travel long distances or search for areas with better network coverage just to attend online classes. In some cases, students relocate temporarily to the homes of relatives or friends in areas with stronger internet signals, further illustrating the extent of this infrastructure disparity.

This inequity in digital access exacerbates existing inequalities in the education system, as students from rural and underdeveloped regions are left at a disadvantage compared to their urban counterparts. Without consistent and widespread internet access, the opportunity to benefit from online learning remains limited to those fortunate enough to live in better-connected areas. This uneven distribution of digital resources not only hampers academic progress but also contributes to long-term disparities in educational outcomes.

These findings underscore the urgent need for comprehensive improvements to digital infrastructure in Bone Regency, especially the provision of stable and equitable internet access across all areas. Expanding the reach of the internet to ensure that even the most remote schools have reliable connections is essential to creating an inclusive and fair education system. Addressing this issue would enable students and teachers in rural areas to fully participate in the digital learning landscape, bridging the gap between rural and urban schools and providing equal opportunities for academic success. Realizing such a vision requires coordinated efforts from both the government and the private sector to invest in infrastructure, technology, and training that can support the sustained growth of digital education in rural regions.

Limitations of digital devices

Limited digital devices are a significant barrier to students in Bone district taking full advantage of the digitalisation of education. Interviews with students and parents show that some students in the region do not have sufficient laptops or tablets to effectively support online learning. This forces most students to rely on mobile phones with limited features, which are not ideal for accessing interactive, immersive and diverse learning content. Mobile phones, while they can be used for online activities, often do not have the same capacity as laptops or tablets in

handling educational applications, project-based tasks, or browsing complex subject matter. As a result, the learning process that should support students' cognitive and skill development is hampered by device limitations.

This limited access to digital devices further widens the gap between rural and urban students. In urban areas, students generally have better access to advanced digital devices such as laptops and tablets, as well as adequate supporting infrastructure, enabling them to follow online learning smoothly. Meanwhile, students in rural areas face a double challenge: not only limited devices but also inadequate internet infrastructure, which puts them further behind. This situation creates inequality in learning opportunities and students' ability to compete academically. While urban students can easily take online classes, do assignments, or access additional resources, rural students struggle to stay connected and complete basic tasks.

In addition, the limitations of digital devices also impact students' ability to develop digital literacy skills that are much needed in this digital age. Digital literacy, which includes the ability to use technology effectively, understand and analyze digital information, and collaborate in an online environment, is becoming increasingly important in modern education. However, without access to adequate devices, students in rural areas find it difficult to hone these skills, which could ultimately affect their readiness to face challenges in an increasingly digitalized world of work.

Digital learning adaptation

The challenge of adapting to digital learning is not only felt by students but also by teachers in rural areas of Bone Regency. Based on interviews with teachers involved in this study, it was revealed that the majority of them have not received adequate training in the use of educational technology. This lack of digital skills is a major obstacle for teachers to optimize online learning platforms. As a result, they often use short message applications such as WhatsApp as a medium to deliver learning materials to students. Although WhatsApp facilitates communication, it is not designed for interactive and comprehensive learning, so the teaching and learning process becomes more one-way.

The use of instant messaging apps as the main tool in learning causes limited interaction between teachers and students. Students rarely get the opportunity to engage in discussions, ask questions, or collaborate with classmates optimally, which ultimately reduces the effectiveness of learning. In the context of digital education, the success of a teaching and learning process depends not only on the delivery of information but also on how the information is understood, processed, and applied by students. Without a platform that allows for two-way interaction, students' understanding of the material tends to be more superficial. The absence of space for students to discuss and explore materials collaboratively hinders the development of their critical thinking skills and problem-solving abilities, which are crucial in the digital era.

Parents' perspective

From the parents' perspective, especially in rural areas, low digital literacy is one of the main obstacles to supporting the effectiveness of online learning. Interviews with two parents showed that they find it difficult to accompany their children during the learning process from home. The inability to operate digital devices, such as laptops or tablets, as well as difficulties in accessing online learning platforms are significant challenges. In addition, they are also unfamiliar with how to use technology to help their children understand and complete assignments given online.

This situation creates a dilemma for parents. On one hand, they have a strong desire to ensure their children stay educated during the pandemic and do not fall behind other students. However, on the other hand, they feel burdened by the need to accompany and assist their children in the online learning process, while their own limited digital knowledge and skills become a hindrance. Many of these parents work in the informal or agricultural sectors, which do not require the use of digital technology in their daily lives. Thus, when their children have to learn with the help of technology, these parents face significant difficulties in providing the necessary support.

Often, parents rely on help from younger family members or neighbors who have better technology skills. However, this is certainly not a sustainable solution, as direct parental involvement is crucial in a child's educational process, especially in supporting student motivation

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and understanding. Parents' inability to actively engage in online learning also has the potential to affect their children's academic performance, as children tend to require additional guidance when they study at home.

DISCUSSION

The research highlighted several aspects of the challenges of digitization of education in remote areas of Bone Regency, specifically related to limited digital infrastructure, access to technological devices, teachers' digital skills, and parents' low digital literacy. The results link the research findings with relevant literature to provide a more comprehensive picture of the problems faced in implementing online learning in rural areas.

Limited digital infrastructure is the main problem hindering the digitization process of education in Bone district, as identified in the results of this study. Unequal internet access in rural areas such as Tellu Limpoe, Bengo, and Bontocani sub-districts exacerbates the gap in online learning. This condition is in line with the findings that poor digital infrastructure can slow down the adaptation of educational technology, especially in rural areas. (Esteban-Navarro et al., 2020). The internet is the backbone of online learning implementation and without adequate access, students and teachers in rural areas experience significant limitations in accessing learning materials, interacting with peers, and participating in full class activities. (Yusriadi et al., 2022). Therefore, improving digital infrastructure, especially a stable and equitable internet network, is an urgent need to promote a more inclusive digitalization of education.

The lack of digital devices among students in remote areas of Bone Regency deepens the education gap between rural and urban areas. From the research results, some students in remote areas do not have adequate laptops or tablets, so they are forced to rely on mobile phones with limited features. This finding underscores the digital divide phenomenon widely discussed in the literature, where disparities in access to technology further widen inequalities in the quality of education (Anggraini et al., 2024; Cahaya et al., 2022). Students in urban areas benefit more from access to sophisticated devices and digital resources, while students in rural areas are left behind due to limited learning facilities. This suggests the need for intervention from both the government and the private sector to provide more equitable access to technological devices so that students in rural areas can have equal learning opportunities.

The challenges faced by teachers in adapting to online learning show that their digital skills are still very limited. Teachers in rural areas often use short message applications such as WhatsApp rather than more interactive online learning platforms. This finding is in line with research emphasizing that teachers often lack the skills to make optimal use of educational technology (Kasim et al., 2022). The lack of training and technical support for teachers also exacerbates this situation, making the learning process one-way and less interactive (Bozkurt et al., 2020; Esteban-Navarro et al., 2020). In fact, interactive educational technology can increase student engagement and enrich their learning experience. Therefore, improving teachers' digital skills through systematic and continuous training is crucial to ensure that teachers are able to utilise technology optimally in the learning process.

Parents' low digital literacy is one of the significant barriers in supporting their children's online learning. Interview results with parents show that they find it difficult to use digital devices and assist their children in online learning. This is consistent with previous findings showing that parents' digital literacy plays an important role in the success of online learning (Adarkwah, 2021). Parents with limited digital literacy tend to feel burdened with the responsibility of helping their children learn at home, resulting in less optimal participation in the learning process. This situation emphasises the importance of digital literacy programmes aimed at parents in rural areas, so that they can effectively support their children in learning online.

Overall, the results of this study highlight that digitisation of education in rural areas of Bone district faces complex challenges, ranging from inadequate digital infrastructure, limited technological tools, teachers' lack of digital skills, to parents' low digital literacy. These challenges are interrelated and exacerbate inequalities in access to quality education in remote areas.

Therefore, a holistic and inclusive approach is needed to address these issues, involving the government, schools, communities and the private sector in realising equitable access to education technology. This joint effort is expected to help create a more inclusive and equitable learning environment where every student, teacher and parent can fully participate in the technology-based education process.

CONCLUSION

This study reveals the complex challenges faced in the digitalization of education in Bone Regency, stemming from limited digital infrastructure, insufficient access to technological devices, inadequate digital skills among teachers, and low digital literacy among parents. These barriers collectively widen the education gap between rural and urban students, hindering equitable access to quality education. Addressing these issues is essential to ensure that students in remote areas are not left behind in the digital age.

To bridge the digital divide, coordinated efforts from the government, educational institutions, private sector, and communities are essential. Key actions include improving digital infrastructure in rural areas, providing targeted training for teachers, and increasing access to digital devices and literacy programs for students and their families. Such initiatives will empower local communities, enable effective technology-based education, and create a more inclusive learning environment for all students.

Future research should explore the long-term impacts of technology on educational outcomes in remote areas, particularly across different subjects and educational levels. Additionally, research comparing digitalization efforts in various rural regions across Indonesia can provide insights into unique challenges and solutions, informing national policy. Evaluating training programs for teachers and parents on digital literacy can further guide improvements in digital education practices.

By addressing these challenges through sustained, collaborative efforts, policymakers can advance digital equity and foster a resilient education system that serves all students, regardless of their geographic location. This call to action emphasizes the urgency of creating a supportive infrastructure that empowers rural communities and ensures that the benefits of digital education reach every corner of the nation.

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