Journal of Education Technology
Volume 9, Number 2, 2025, pp. 258-270
P-ISSN: 2549-4856 E-ISSN: 2549-8290
Open Access: https://ejournal.undiksha.ac.id/index.php/JET

Bridging the Digital Divide in Education: Disparities in Google Classroom Utilization and Technical Challenges among Urban and Rural Teachers

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ARTICLE INFO

Article history:
Received February 08, 2025
Accepted April 30, 2025
Available online May 25, 2025

Kata Kunci:
Pembelajaran Digital; Kesenjangan Digital; Kendala Teknis; Google Classroom*; Pendidikan Berbasis Teknologi*

Keywords:
Digital Divide; Teacher Readiness; Online Learning; Instructional Technology; Google Classroom

DOI:
https://doi.org/10.23887/jet.v9i2.92897

ABSTRAK

Kesenjangan digital masih menjadi hambatan serius dalam pelaksanaan pembelajaran daring di Indonesia. Ketimpangan akses terhadap Teknologi Informasi dan Komunikasi (TIK) terlihat jelas, di mana wilayah perkotaan memiliki infrastruktur digital yang jauh lebih baik dibandingkan wilayah pedesaan. Penelitian ini bertujuan untuk menganalisis perbedaan faktor pendukung pembelajaran daring antara guru sekolah menengah di daerah dengan karakteristik geografis yang kontras, khususnya terkait koneksi jaringan, kendala teknis, infrastruktur sekolah, dan penggunaan Google Classroom*. Sebanyak 395 guru berpartisipasi dalam survei daring menggunakan kuesioner tertutup yang terdiri dari 22 item. Analisis data melalui statistik deskriptif dan uji-t menunjukkan bahwa guru di wilayah pedesaan menghadapi kendala teknis yang lebih tinggi dan pemanfaatan* Google Classroom *yang lebih rendah dibandingkan guru di wilayah perkotaan. Penelitian ini memberikan kontribusi empiris terhadap pemetaan dimensi kesenjangan digital antarwilayah dan menekankan urgensi strategi berbasis wilayah, seperti pelatihan literasi digital adaptif dan distribusi perangkat secara proporsional. Hasil ini dapat dijadikan dasar dalam merumuskan kebijakan pendidikan yang lebih inklusif dan berkeadilan di era digital.*

ABSTRACT

The digital divide remains a serious obstacle to the implementation of online learning in Indonesia. The inequality of access to Information and Communication Technology (ICT) is clearly visible, where urban areas have much better digital infrastructure than rural areas. This study aims to analyze the differences in supporting factors for online learning between secondary school teachers in areas with contrasting geographical characteristics, especially related to network connections, technical constraints, school infrastructure, and the use of Google Classroom. A total of 395 teachers participated in an online survey using a closed questionnaire consisting of 22 items. Data analysis through descriptive statistics and t-tests showed that teachers in rural areas faced higher technical constraints and lower utilization of Google Classroom compared to teachers in urban areas. This study provides an empirical contribution to mapping the dimensions of the digital divide between regions and emphasizes the urgency of region-based strategies, such as adaptive digital literacy training and proportional device distribution. These results can be used as a basis for formulating more inclusive and equitable education policies in the digital era.

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1. INTRODUCTION

The COVID-19 pandemic has accelerated a major transformation in global education, driving the rapid and widespread adoption of digital technologies (Koumiti et al., 2024; Sjahruddin et al., 2022). This shift has led to the extensive use of online learning platforms, video conferencing tools, and digital applications to sustain educational activities during lockdowns and social restrictions. Innovations such as augmented reality and virtual reality have further enhanced student engagement, creating immersive learning experiences across various disciplines (Gulyanto & Sari, 2023; Koumiti et al., 2024). This phenomenon aligns with disruptive innovation theory, wherein technology integration not only reshapes traditional learning models but also redefines the value of education (Andriani et al., 2022; Manocha et al., 2022). In response, educational institutions have adapted by incorporating digitalization into academic activities, with some universities transitioning entirely to online teaching. This digitalization trend is expected to persist beyond the pandemic, with hybrid learning models becoming increasingly prevalent across educational levels (Haleem et al., 2022a; Hartati et al., 2022). The COVID-19 pandemic has accelerated the shift to online education, exacerbating existing digital disparities and posing significant challenges for both students and educators (Ceviker & Gezer, 2023; Iftıkhar et al., 2023).

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Socioeconomic status, geographical location, and access to technology have emerged as key determinants in widening this gap (Ceviker & Gezer, 2023; Esteban Jr. & Cruz, 2021). Studies in Pakistan, the Philippines, and Nepal indicate that students from rural areas and low-income families face greater barriers to effective online learning (Baral, 2022; Esteban Jr. & Cruz, 2021; Iftıkhar et al., 2023). Digital inequality extends beyond access to technological devices, encompassing disparities in digital literacy among both students and educators. Enhancing information and communication technology (ICT) proficiency is crucial for maximizing the effectiveness of online learning (Ceviker & Gezer, 2023; El-Senousy & Alquda, 2017). While online education offers a viable alternative during emergencies, it also risks deepening educational inequities, particularly for those lacking access and digital competencies. Addressing this issue requires strategic interventions from governments and educational institutions. Investments in infrastructure, targeted training programs for educators, and support for vulnerable student populations are essential to fostering a more inclusive online learning ecosystem and ensuring equitable access to quality education (Baral, 2022; Ceviker & Gezer, 2023).

The digital divide in education encompasses disparities in ICT access, skills, and utilization between teachers and students, shaped by various contextual factors. In China, significant differences in ICT competencies between urban and rural teachers are influenced by their environment and digital literacy levels (Loudova, 2021; Zhao, 2024). In Pakistan, the gap extends beyond physical access to include motivation, skills, and ICT integration in teaching, directly impacting instructional effectiveness. Although ICT resources are equitably available in inclusive classrooms in the UAE, insufficient training and resource support remain critical barriers, exacerbating the digital divide (AlSadrani et al., 2020; Soomro et al., 2020). The COVID-19 pandemic further highlighted the complexities of ICT access, as South African teachers encountered three dimensions of digital disparity in online learning through Virtual Classrooms, WhatsApp, and Radio-Television platforms (Kamińska et al., 2023; Kennedy & Cronjé, 2023). These findings underscore the urgency of a holistic, context-driven approach to addressing the digital divide, emphasizing enhanced accessibility, strengthened digital competencies, and optimized ICT integration in pedagogical practices to foster a more inclusive and effective educational ecosystem.

The digital divide between rural and urban areas remains a critical challenge, primarily due to low broadband adoption rates and limited access to advanced ICT services in rural regions (Hollman et al., 2020; Rubach & Lazarides, 2021). This disparity significantly impacts various aspects of life, particularly education, where rural students face greater barriers to accessing online learning materials compared to their urban counterparts. The issue is especially pronounced in developing countries such as Indonesia, where inadequate digital infrastructure in rural areas hampers skill development and the effective utilization of digital technology (Hadi, 2018; Lembani et al., 2019). While ICT adoption has increased, digital technologies have not entirely replaced traditional mobility patterns in either urban or rural settings. Instead, they function as complementary tools, enhancing cost-effective travel planning, particularly with the growing availability of telecommunication services in rural areas. Addressing the digital divide thus requires a holistic approach that acknowledges the interconnectedness of rural and urban regions, including information flows and population mobility, to formulate more comprehensive and effective policies (Aderibigbe & Gumbo, 2024; Hadi, 2018).

Research consistently highlights a persistent digital divide between urban and rural schools, where urban institutions generally benefit from better access to technology and digital resources. This disparity directly affects students' learning experiences and academic achievement (Haleem et al., 2022b; Yu et al., 2023). Technological inequities extend across different countries. In South Africa, rural students in remote learning settings face significantly greater obstacles than their urban counterparts due to limited access to Information and Communication Technology (ICT) (Lembani et al., 2019). In China, studies indicate that urban elementary school mathematics teachers demonstrate higher proficiency in Technological Pedagogical Content Knowledge (TPACK) and hold more positive attitudes toward technology integration compared to their rural counterparts (Mao Li, 2024). Conversely, research in the United States reveals that urban teachers lag behind their rural and suburban peers in both technology use and perceptions of its effectiveness, with suburban educators exhibiting the highest confidence in technology's instructional benefits (Kormos, 2018). These findings underscore that the digital divide extends beyond mere access to technology; it also encompasses teachers' competencies in leveraging digital tools to enhance learning quality. Addressing this gap requires more inclusive policies that ensure equitable access to technology while simultaneously strengthening educators' capacity for effective technological integration, particularly in underserved regions.

The digital divide in Indonesia remains a critical issue, particularly in education, where disparities between urban and rural areas are pronounced. In Banten Province, cities such as Tangerang, South Tangerang, and Serang benefit from advanced technological infrastructure, high internet penetration, and stronger digital literacy among educators (Nuryatin et al., 2023; Tarteer et al., 2021). In contrast, rural areas like Lebak and Pandeglang face persistent challenges, including limited internet access, a shortage of digital devices, and low technical proficiency among teachers. Prior research highlights that urban schools are better equipped for digital transformation than their rural counterparts, which often struggle with digital readiness and accreditation standards (Hadi, 2018; Supardi et al., 2024; Tarteer et al., 2021; Wen & Hua, 2020). This divide is not merely geographical but also reflects socio-economic inequalities, disparities in access to digital resources, and variations in educators'

technological competencies and usage patterns. More broadly, the digital gap follows a declining development trajectory from west to east and from urban centers to peripheral regions, although studies indicate a narrowing digital divide between 2015 and 2019, significant challenges persist, particularly for educators in coastal and remote areas who continue to struggle with technological adaptation and digital learning constraints (Hamsiah et al., 2024; Kartiasih et al., 2022). Addressing this issue requires targeted strategic interventions, including enhanced professional training for teachers and expanded technological infrastructure in underprivileged regions.

Although Google Classroom has proven effective in supporting the learning process across various educational levels and disciplines, the widening digital divide between urban and rural schools remains a major barrier to achieving equitable quality in online education (Faisal et al., 2024; Shak et al., 2024; Virginia; et al., 2022; Wang et al., 2024). According to a report from the Data and Information Center of the Indonesian Ministry of Education, only about 42% of schools in 3T (underdeveloped, frontier, and outermost) areas have access to stable internet connections, a stark contrast to the 85% in urban regions. Findings by previous researches further reveal that teachers in remote areas often face limited internet access, lack of technological training, and insufficient supporting infrastructure (Akram et al., 2022; Torres, K. M., & Giddie, 2020). These challenges underscore the reality that technological integration is not merely about adopting digital platforms; rather, it critically depends on systemic readiness, which encompasses the availability of devices, digital literacy, and robust institutional and policy support (Basta & Pejić, 2023; Kormos, 2018; Oluyinka & Cusipag, 2021).

A number of studies have highlighted various challenges in the integration of Google Classroom across different educational contexts. Although the platform is widely recognized for its potential to enhance student achievement and has received positive responses regarding material accessibility and the efficiency of feedback, its implementation remains far from optimal (Akcil et al., 2021; Rosyada & Sundari, 2021; Shak et al., 2024). While numerous studies on the effectiveness of Google Classroom have developed countries, research that specifically compares the facilitating conditions and levels of adoption across regions, especially in developing countries like Indonesia, remains limited (Kennedy & Cronjé, 2023; Mao Li, 2024). Moreover, most existing studies tend to focus solely on short-term user perceptions and have yet to incorporate longitudinal approaches capable of capturing the dynamic nature of technology adoption over time (Shak et al., 2024; Xue et al., 2024). To address this gap, it is essential to establish an analytical framework grounded in robust theoretical perspectives. The Technological Pedagogical Content Knowledge (TPACK) framework and the concept of Facilitating Conditions within the Unified Theory of Acceptance and Use of Technology (UTAUT) model offer relevant conceptual foundations for examining how technological competence, infrastructure availability, and institutional support influence the successful integration of Google Classroom across diverse regional contexts (Irwanto, 2021; Nuangchalerm, 2020).

Therefore, this study aims to analyze significant differences in supporting conditions, including network connectivity, technical barriers, and school infrastructure, between teachers in rural and urban areas in utilizing Google Classroom and identify significant differences in the level of Google Classroom adoption between these two groups. By empirically mapping the challenges and opportunities in educational technology integration, this study is expected to contribute meaningfully to the development of inclusive, evidence-based, and contextually adaptive education policies that are responsive to Indonesia's geographical and socioeconomic diversity.

2. METHOD

This study employs a quantitative comparative approach using a non-experimental, cross-sectional survey design to investigate statistically significant differences in support conditions and the level of Google Classroom adoption among secondary school teachers in urban and rural areas. This study involved 395 junior high school teachers (SMP) from five regencies/cities in the Province of Banten, Indonesia. Participants were selected using a stratified random sampling technique based on the classification of urban and rural areas as defined by the Ministry of Home Affairs. A total of 213 participants were from urban areas (Tangerang City, South Tangerang City, and Serang City), while 182 participants were from rural areas (Lebak Regency and Pandeglang Regency). The selection of Banten Province as the research site was based on the stark contrast between regions with advanced digital infrastructure (such as Greater Tangerang) and those still facing numerous limitations (such as Lebak and Pandeglang). This disparity makes Banten a strategic location for empirically examining the digital divide in education, particularly in relation to the implementation of Google Classroom in areas with differing geographical and infrastructural characteristics. The sample size was determined based on two primary considerations. A demographic characteristic of research participants is show in Table 1.

Table 1. Demographic Characteristics of Research Participants (N = 395)

Characteristic	Urban (n = 213)	Rural (n = 182)	Total (N = 395)
Gender			
- Male	102 (47.9%)	85 (46.7%)	187 (47.3%)

Characteristic	Urban (n = 213)	Rural (n = 182)	Total (N = 395)
- Female	111 (52.1%)	97 (53.3%)	208 (52.7%)
Age			
- < 30 years	36 (16.9%)	32 (17.6%)	68 (17.2%)
- 30 – 39 years	84 (39.4%)	75 (41.2%)	159 (40.3%)
- 40 – 49 years	69 (32.4%)	58 (31.9%)	127 (32.2%)
- ≥ 50 years	24 (11.3%)	17 (9.3%)	41 (10.4%)
Teaching Experience			
- < 5 years	28 (13.1%)	22 (12.1%)	50 (12.7%)
- 5 – 10 years	70 (32.9%)	55 (30.2%)	125 (31.6%)
- > 10 years	115 (54.0%)	105 (57.7%)	220 (55.7%)
Google Classroom Usage			
- ≥ 1 semester	213 (100%)	182 (100%)	395 (100%)

The data presented in Table 1 indicates that participants from both urban and rural areas exhibit a relatively balanced demographic distribution in terms of gender, age, and teaching experience. This composition reflects the diversity of junior high school teachers in Banten Province, which is pertinent to the context of digitalization in education. Furthermore, Table 2 visualizes the distribution of participants across administrative regions, clarifying the proportion of participants from each district or city. This distribution supports the validity of inter-regional comparisons and reinforces the representativeness of the data, as it includes urban areas with relatively well-established technological infrastructure (e.g., Tangerang City and South Tangerang) as well as rural areas with limited digital access (e.g., Lebak and Pandeglang).

Table 2. Distribution Of Participants By Administrative Region

District/City	Classification	Number of Teachers	Percentage (%)
Tangerang City	Urban	70	17.7%
South Tangerang	Urban	65	16.5%
Serang City	Urban	78	19.7%
Lebak Regency	Rural	90	22.8%
Pandeglang Regency	Rural	92	23.3%
Total	—	**395**	**100%**

The data in both tables above demonstrate that the characteristics of participants from urban and rural areas are relatively evenly distributed in terms of gender, age, and teaching experience. All participants met the criterion of having prior experience using Google Classroom, thereby ensuring that the data collected is valid and reliable for comparative analysis. This composition supports the research objective of identifying differences in enabling conditions and levels of Google Classroom adoption based on geographical background. Additionally, it enhances the validity and representativeness of the findings for informing inclusive, region-based digital education policies. Data were collected through a structured online questionnaire distributed via Google Forms. This instrument was specifically designed to measure two main constructs: facilitating conditions and the frequency of Google Classroom usage among secondary school teachers. The development of this instrument was grounded in the Unified Theory of Acceptance and Use of Technology (UTAUT) (Irwanto, 2021; Nuangchalerm, 2020; Xue et al., 2024),

The data analysis in this study was conducted in a gradual and systematic manner to ensure both transparency and accuracy in the interpretation of findings. The initial stage involved screening the data to ensure that only fully completed questionnaires meeting the inclusion criteria specifically, teachers who had used Google Classroom for at least one semester were included in the further analysis. All data were processed using IBM SPSS Statistics version 25.0. The analysis began with descriptive statistics to illustrate the demographic characteristics of the respondents, such as teaching region, gender, and teaching experience. In addition, descriptive statistics were employed to analyze central tendencies (mean and median) and data dispersion (standard deviation) for each of the variables under investigation (Kalkbrenner, 2021; Shak et al., 2024; Sidek et al., 2020). Accordingly, before conducting the t-test, the study first tested the assumptions of normality and homogeneity of variance. Based on the results, all significance values from the Kolmogorov-Smirnov and Levene's tests are above 0.05. This indicates that the data distribution satisfies the assumptions of normality, and the variances between groups are homogeneous. Therefore, the use of the independent samples t-test is statistically appropriate. To anticipate potential violations of the homogeneity assumption in future analyses, the researcher also prepared an alternative approach using Welch's t-test, which is more robust against unequal variances (Irwanto, 2021; Nuangchalerm, 2020; Xue et al., 2024).

3. RESULT AND DISCUSSION

Result

A total of 395 secondary school teachers from Banten Province, Indonesia, participated as respondents in this study. They were drawn from two regional categories: urban areas (Tangerang City, South Tangerang, and Serang) and rural areas (Lebak and Pandeglang). Demographic data were collected to provide contextual insights into the population representation, including gender, age group, teaching experience, and school location. Demographic information is show in Table 3.

Table 3. Demographic Information

Measure		Frequency (f)	Percent (%)
Gender	Male	105	26.6
	Female	290	73.4
Age group	25 – 35	92	23.3
	36 – 45	175	44.3
	46 – 55	96	24.3
	56 and above	32	8.1
Years of teaching experience	Under 10	85	21.5
	11 – 15	115	29.1
	16 – 20	87	22.0
	21 and above	108	27.3
Area	Rural (Lebak, Pandeglang)	160	40.5
	Urban (Serang, Tangerang, Tangerang Selatan)	235	59.5

Base on Table 3, the majority of respondents were female (73.4%), while male teachers accounted for only 26.6%. This composition reflects the gender distribution commonly found in the Indonesian teaching profession, which is predominantly female, as also reported in the national educator distribution report by the Ministry of Education, Culture, Research, and Technology. In terms of age, the respondents were predominantly in the 36–45 age group (44.3%), followed by those aged 46–55 (24.3%) and 25–35 (23.3%). This indicates that most teachers are in the mid-career phase, which is generally considered to offer a balance between professional experience and adaptability to new technologies. The distribution of teaching experience showed a relatively even composition, with 56.4% of teachers having more than 15 years of service. This suggests a stable profession and the potential for long-term engagement in policy changes. Geographically, 59.5% of the teachers were from urban areas, while 40.5% were from rural regions, aligning with the concentration of schools and access to educational facilities that tend to be more centralized in urban settings. These findings are particularly relevant to the primary objectives of the study, as demographic factors, especially school location and teaching experience, serve as important indicators in examining access to technology, digital readiness, and disparities in the adoption of Google Classroom. For instance, the predominance of experienced teachers in urban areas may contribute to more intensive technology adoption compared to rural areas, which often face constraints in infrastructure and technology training. To clarify the primary trends within the data, a graphical visualization is provided in Figure 1, illustrating the dominant proportions across each category. This representation highlights the distribution patterns of teachers based on region, gender, age, and teaching experience factors that are pertinent for understanding the context of technology adoption across different groups.

Base on Figure 1 show the analysis revealed a significant difference in network connectivity, with urban teachers reporting a higher mean score (M = 3.540) compared to their rural counterparts (M = 3.210), with a significance level of $p = 0.019$. This finding suggests that teachers in urban areas have more stable access to internet connectivity, which is a fundamental prerequisite for the sustained integration of online learning technologies. Regarding technical constraints, teachers in rural areas were found to experience greater challenges (M = 2.920) than those in urban areas (M = 3.100), with a significance value of $p = 0.043$. This indicates a disparity in teachers' technical capacity, both in terms of technology usage skills and access to institutional technical support. For the school infrastructure variable, the results showed no significant difference between the two regions ($p = 0.223$), although urban teachers had a slightly higher average score (M = 4.200) compared to rural teachers (M = 4.000). This suggests that physical facilities such as computer laboratories, technological devices, and digitally equipped classrooms are relatively evenly distributed across both settings.

However, a marked difference was observed in the use of Google Classroom. Teachers in urban areas reported significantly higher levels of usage (M = 3.900) than those in rural areas (M = 3.420), with a significance level of $p < 0.001$. This finding implies that the adoption of digital platforms is not solely dependent on infrastructure but is also strongly influenced by network availability, technical competencies, and the psychological and professional readiness of teachers to engage with online learning technologies. In conclusion, the findings underscore a clear digital divide between teachers in urban and rural areas, particularly in terms of

connectivity, technical challenges, and the utilization of Google Classroom. In contrast, no substantial disparity was found in terms of school infrastructure. These results highlight the urgent need for region-specific education policies that prioritize enhanced digital access and the strengthening of teachers' technical capabilities in under served areas, ensuring they are not left behind in the national digital education transformation. Table 4 below summarizes the results of the t-test, highlighting the significance levels of differences between the two regions across each variable.

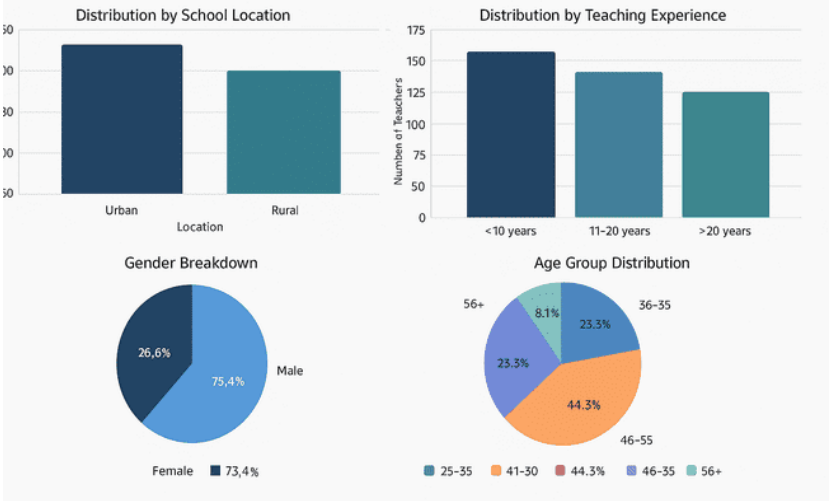

Figure 1. Demographic Analysis of Secondary School Teachers in Banten

Table 4. T-Test Results Between Regions

Variable	Mean (Urban)	Mean (Rural)	t(df)	p-value
Network Connectivity	3.540	3.210	-2.354	0.019
Technical Constraints	3.100	2.920	2.030	0.043
School Infrastructure	4.200	4.000	-1.219	0.223
Use of Google Classroom	3.900	3.420	3.762	<0.001

Based on the results presented in Table 4, the t-test indicates significant differences between teachers in urban and rural areas in terms of network connectivity, technical constraints, and the use of Google Classroom. Figure 2 illustrates the average scores of each variable, highlighting the digital gap between regions. It is evident that teachers in urban areas scored higher, particularly in the variables related to the use of Google Classroom and network connectivity, suggesting better access to and utilization of technology. This study confirms the presence of a digital divide between urban and rural teachers in Banten Province in terms of Google Classroom utilization, particularly concerning network connectivity, technical limitations, and levels of usage. To examine the hypotheses and identify any statistically significant differences between the two regions, an independent *t*-test was conducted.

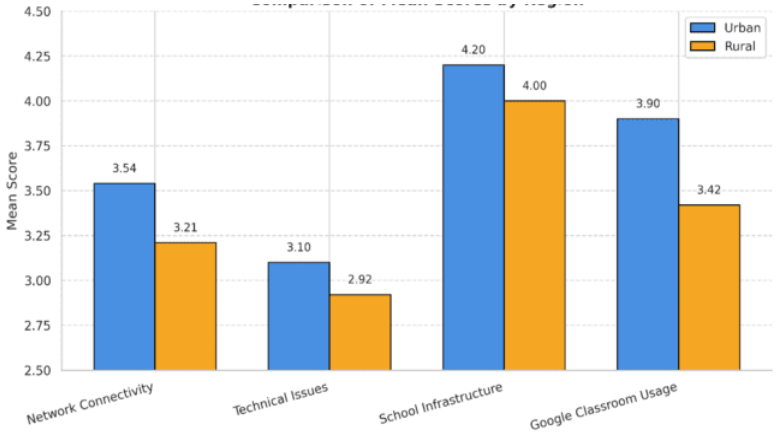

Figure 2. Comparison of Mean Scores by Region

Discussion

Disparities in Network Access for Teachers in Urban and Rural Areas

This disparity directly affects the digital readiness of schools and teachers and deepens the educational achievement gap between regions. Similarly previous studies highlights disparities in digital infrastructure as a key barrier to technology-driven educational inclusion, particularly in developing countries (Booth et al., 2021; Sum & Oancea, 2022). In line with these findings, previous studies have also identified inadequate network infrastructure as a major obstacle to the adoption of educational technology in under served areas (Hasin & M Nasir, 2021). In Malaysia, poor and uneven internet connectivity has hindered the implementation of digital platforms in rural schools (Hui et al., 2022). Likewise, other study emphasize that digital infrastructure limitations in rural Indonesia are structural and persistent (Junaidi & Hashim, 2021). Beyond mere access, these conditions also affect student engagement, learning satisfaction, and academic outcomes (Henderson, J., & Corry, 2021; Hou & Royo, 2024; Lembani et al., 2019; Raduan & Na, 2020). In Banten Province, this disparity is further amplified by geographic and institutional capacity differences. Urban areas such as Tangerang, South Tangerang, and Serang benefit from relatively stable network infrastructure and adequate digital devices. In contrast, districts like Lebak and Pandeglang continue to face network instability, limited ICT devices, and a lack of capacity-building initiatives aimed at enhancing teachers' digital literacy. Teachers in rural areas also endure higher workload pressure and lack access to technical support when encountering technological challenges, as also documented in post-pandemic studies (Soekamto et al., 2022; Zamir & Wang, 2023). Without guaranteed equitable digital access, both students and teachers in rural areas risk further marginalization from 21st-century education. However, connectivity alone is not the only critical factor. Network access is merely one component of a broader school digital ecosystem. When connectivity is not accompanied by institutional support, digital pedagogy training, and transformative school leadership, the implementation of technology often becomes fragmented and unsustainable.

In the context of teacher education and curriculum development, the urgency of these disparities necessitates the integration of digital pedagogical competencies into both pre-service teacher training and continuous professional development. Teacher education institutions (LPTKs) should form strategic partnerships with local governments to design localized training programs that respond to geographical challenges and align with relevant educational contexts. Ultimately, with a well-targeted, collaborative, and data-driven approach, teachers in rural areas can not only bridge the digital divide but also serve as agents of digital transformation, helping to build a more inclusive, adaptive, and equitable education ecosystem.

Digital Operational Challenges Faced by Teachers in Urban and Rural Areas

The findings align with the global literature observed that rural teachers disproportionately face greater technical obstacles due to limited digital infrastructure and scarce training opportunities (M. Li, 2025; Mao Li, 2024). Previous study emphasized that the successful adoption of educational technology is heavily contingent upon adequate technical support and digital literacy (Kormos, 2018). Moreover, this technical gap is closely linked to pedagogical asymmetry, particularly regarding mastery of Technological Pedagogical Content Knowledge (TPACK). Research by other study found that urban teachers consistently demonstrate stronger digital instructional skills, higher self-confidence, and superior teaching competence (Lavanya et al., 2024; Lin et al., 2023). This disparity stems not only from technological differences but also from unequal access to professional development, institutional innovation culture, and hands-on experience with digital tools. Previous study noted that urban mathematics teachers exhibit more positive and open attitudes toward the integration of technology in teaching (Lin et al., 2023). This is influenced by their more frequent participation in ICT training, supportive work environments, and higher levels of data literacy. In contrast, rural teachers often face challenges such as fragmented devices, a lack of peer mentors, and limitations in data management, all of which hinder their readiness to implement digital learning effectively.

Confirmation of Hypothesis H2 in this study underscores that digital inequality in Indonesia's education system is both structural and multidimensional. Accordingly, a multi-layered and practice-based policy response is required, including: 1) The equitable provision of compatible and high-quality digital devices, particularly for schools in disadvantaged areas; 2) Intensive and contextually grounded digital pedagogy training, delivered through both face-to-face sessions and blended learning formats; and 3) The establishment of regional ICT mentoring centers to promote peer-to-peer technical support among teachers that is responsive to local contexts. In addition, the development of teacher education curricula and teacher training institutions (LPTK) must incorporate modules on digital problem-solving, the TPACK framework, and data literacy skills both in pre-service training and in ongoing professional development, especially for prospective teachers assigned to regions with limited access. Although these challenges present significant obstacles, they also offer opportunities for transformative policy reform. With a context-sensitive and targeted digital approach, teachers in rural areas can not only bridge the digital divide but also serve as change agents in advancing a model of education that is inclusive, adaptive, and technologically sustainable.

School Infrastructure in Urban and Rural Areas

The result reflects a general infrastructural parity that has been largely achieved through various government initiatives. One of the key contributors to this parity is the *Dana Alokasi Khusus* (DAK or Special Allocation Fund) for education, along with the ICT laboratory revitalization programs in 3T areas (*tertinggal*, *terdepan*, *terluar* – underdeveloped, frontier, and outermost regions). This situation is corroborated by study who found that public schools in urban settings are generally better prepared to utilize digital infrastructure and tend to have higher accreditation levels compared to private and suburban schools (Derder et al., 2023). Meanwhile, other study reported that schools in North Sumatra, especially those in remote areas, continue to face deficits in digital facilities, including unreliable internet connectivity and unstable electricity supply (Harahap et al., 2024). An international study highlighted that small-scale infrastructure projects, such as the provision of laboratories and localized internet access, have had a more profound impact in rural Ecuador than large-scale, top-down initiatives. However, not all studies support the existence of structural disparities in their research conducted in Kedah, Malaysia, argue that barriers to ICT implementation are not always rooted in physical conditions (Aderibigbe & Gumbo, 2024; Hou & Royo, 2024). Rather, they stem from teacher competencies, school policy support, and institutional digital literacy. These findings suggest that physical infrastructure gaps may become irrelevant if not accompanied by strengthened human and institutional capacities.

These findings have direct implications for the achievement of Sustainable Development Goal (SDG) 4.a, which advocates for the creation of safe, inclusive, and technology-enabled learning environments. In alignment with school infrastructure development should not only emphasize the provision of physical assets but also ensure alignment with digital transformation policies and the readiness of human resources. With relatively equitable infrastructure distribution, the primary challenge now shifts towards functionality, training, and the integration of technology into teaching practices. Therefore, evidence-informed policy interventions must include the following strategic components: 1) Systemic enhancement of digital pedagogy training, particularly in rural schools where LMS- and TPACK-based training remains insufficient; 2) Context-sensitive infrastructure management policies that allow schools greater autonomy in the maintenance and effective use of digital assets; and 3) Cross-sector collaboration between government, teacher training institutions (LPTK), and the educational technology industry to co-develop contextually appropriate and sustainable solutions. These findings reveal strategic opportunities to optimize the use of existing digital infrastructure through a practice-informed policy approach, with a focus on strengthening institutional capacity and digital leadership at the school level. By ensuring that established infrastructure is utilized effectively and sustainably, digital transformation in education can serve as a powerful instrument for bridging regional disparities in educational quality.

The Utilization Rate of Google Classroom Among Teachers in Urban and Rural Areas

The disparity indicates a structural asymmetry in the adoption of digital technology-based Learning Management Systems (LMS), reflecting unequal access to infrastructure, digital competence, and institutional support. This discrepancy is further supported which reported that only 27.4% of schools in rural areas regularly use LMS platforms such as Google Classroom, in stark contrast to more than 62% in urban regions. Such a gap highlights the real challenges within facilitating condition, particularly in terms of access to devices, stable internet connectivity, and ongoing digital pedagogy training (Maduku, 2017; Zulherman et al., 2021). Urban areas like Tangerang City and South Tangerang, as economic growth centers in Banten, benefit from a more developed educational technology ecosystem characterized by robust digital infrastructure, higher levels of digital literacy, and regular access to TPACK-based professional development. These factors enable teachers to integrate platforms like Google Classroom into the learning process more effectively. In addition, social support from parents and students in urban settings has also been shown to significantly enhance the successful implementation of digital learning (Haleem et al., 2022a; Irawan, 2022).

The effectiveness of digital platform utilization is significantly influenced by the availability of digital resources, pedagogical competencies, and systemic technical support (Derder et al., 2023; Supardi et al., 2024). Further study indicate a positive correlation between the quality of digital infrastructure and school accreditation status, highlighting that public schools in urban areas are generally more prepared to adopt technology than their suburban and rural counterparts (Dervishi & Vrapi, 2022). In the context of the COVID-19 pandemic, research reveals that teachers in rural areas tend to prefer applications such as WhatsApp for online learning due to their data efficiency and usability in conditions with weak internet connectivity (Hou & Royo, 2024; Maru et al., 2021). In contrast, the use of platforms like Google Classroom and YouTube is more prevalent in urban regions, where electricity and device availability are more reliable. Previous study note that rural teachers face significant challenges, including limited access to electricity, unstable internet connections, and low student ownership of digital devices (Derder et al., 2023). From a psycho-social perspective, assert that performance expectancy, effort expectancy, social influence, and facilitating conditions play critical roles in shaping teachers' intention to adopt technology. To enhance the quality of online learning, recommend optimizing the interactive features of Google Classroom to better facilitate student engagement (Basta & Pejić, 2023; Zulherman et al., 2021).

General Discussion: Contribution, Novelty, Implication, Limitation, and Future Direction

The practical contribution of this research is particularly significant in the context of educational policy development. The findings indicate that, although no statistically significant difference was observed in school infrastructure ($p = 0.223$), stark disparities persist in terms of network utilization, technical constraints, and Google Classroom usage. This reveals a functional inequality in the operation of educational technology that directly affects the effectiveness of learning, particularly in resource-constrained schools. Therefore, the outcomes of this study provide a solid empirical foundation for evidence-based policy making, including the development of region-specific teacher training programs, the integration of TPACK competencies into pre-service teacher education curricula, and the formulation of digital infrastructure development strategies that emphasize utility and sustainability. Strategically, the findings of this study are highly relevant to the targets of Sustainable Development Goal (SDG) 4, particularly indicators 4.a and 4.c, which emphasize the importance of creating safe, inclusive, and digitally-oriented learning environments, as well as enhancing teacher qualifications through international cooperation. However, this study is not without limitations. Geographically, the research is confined to five districts/cities within Banten Province, which may not fully capture the complexity of digital disparities in Indonesia's frontier, outermost, and least-developed regions (known as 3T areas). Moreover, the use of self-reported questionnaire data may introduce bias, particularly in assessing digital literacy levels or the intensity of LMS (Learning Management System) usage. Additionally, the cross-sectional nature of the study limits its ability to reflect dynamic changes in teachers' digital behaviors post-pandemic or the long-term impact of ongoing policy interventions.

Based on these findings, several directions for future research are recommended. First, longitudinal and mixed-method approaches are needed to explore the dynamics of teachers' digital behavior more deeply. Second, the geographic scope should be expanded to include Eastern Indonesia and 3T regions, to enrich the national mapping of digital disparities. Third, subsequent research could examine more specifically the relationship between behavioral intention and the actual use of LMS by employing extended models such as TAM (Technology Acceptance Model) or UTAUT (Unified Theory of Acceptance and Use of Technology). Lastly, the roles of school leadership, institutional culture, and community engagement should also be explored as mediating variables that significantly influence the success of digital transformation. This study also serves as a foundation for deeper pedagogical transformation. By providing contextual and evidence-based insights, it contributes to the development of a data-driven digital intervention roadmap that not only bridges technological gaps but also strengthens a more inclusive, adaptive, and resilient educational ecosystem in the 21st century.

The implications of these findings transcend the local context and provide a foundation for the development of inclusive and equitable digital education policies. Rather than treating infrastructure equalization as the ultimate goal, this study advocates for a paradigm shift in educational policy, one that emphasizes strengthening teacher capacity, integrating TPACK-based training into teacher education and professional development programs, and enhancing digital leadership that is responsive to geographical disparities. Looking ahead, both educational research and practice must focus on empowering teachers as agents of digital transformation within educational institutions. Technology should not merely be viewed as a supplementary tool but rather as a catalyst for creating adaptive, inclusive, and high-quality learning experiences, regardless of students' geographic locations.

4. CONCLUSION

This study underscores the urgency of bridging the digital divide in education by empirically identifying concrete disparities in the use of Google Classroom and technical readiness between teachers in urban and rural areas of Indonesia. It successfully addresses key questions regarding digital preparedness and the geographical adoption of Learning Management Systems (LMS), revealing that the integration of educational technology remains uneven. The findings demonstrate that the digital divide extends beyond physical infrastructure and is deeply rooted in technical barriers, limited access to training, insufficient institutional support, and low pedagogical capacity among teachers to utilize technology meaningfully. Rural teachers face more complex structural and operational challenges compared to their urban counterparts. By employing a multidimensional, region-based comparative framework grounded in the Unified Theory of Acceptance and Use of Technology (UTAUT) and Technological Pedagogical Content Knowledge (TPACK) theories, this study offers significant conceptual contributions to the literature on digital education. It expands our understanding of how the digital divide directly impacts the quality of teaching and learning processes while highlighting the need for more contextualized, evidence-based interventions.

5. ACKNOWLEDGE

The authors express their gratitude to the Institute for Research and Community Service (LPPM), Universitas La Tansa Mashiro, for funding support through the Internal Research Grant Program. Appreciation is

also extended to academic advisors, colleagues, research assistants, and technical staff for their valuable contributions. Lastly, sincere thanks go to all individuals and institutions that have supported this research.

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