Al-Ishlah: Jurnal Pendidikan
Vol.18, 2 (June 2026), pp.2899-2913
ISSN: 2087-9490 EISSN: 2597-940X, DOI: 10.35445/ alishlah.v18i2. 9111

School Digitalization Policy and Learning Inequality in Indonesia's 3T Regions: A Systematic Literature Review

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ARTICLE INFO

Keywords:
school digitalization;
learning inequality;
3T regions

Article history:

Accepted 2025-12-08
Revision 2026-02-10
Accepted 2026-06-30

ABSTRACT

Educational digitalization has become a policy priority in Indonesia, particularly as a strategy to expand access and reduce educational inequality in disadvantaged, frontier, and outermost (3T) regions. However, infrastructure gaps, limited connectivity, low teacher readiness, and weak school ecosystem support indicate that digitalization does not automatically produce equitable learning. This study systematically analyzes the relationship between school digitalization policy and learning inequality in primary schools located in Indonesia's 3T regions. Using a systematic literature review incorporating grey literature and guided by PRISMA 2020, this study analyzes 20 selected sources, including peer-reviewed journal articles, selected conference papers, and official reports or grey literature, through selection, quality appraisal, data extraction, and thematic synthesis. The findings show that school digitalization has a dual effect. It can expand access to learning resources, increase learning flexibility, and support pedagogical innovation. However, it can also reproduce learning inequality when implemented without adequate attention to infrastructure readiness, teachers' digital competence, household access, learning content quality, and school managerial capacity. Learning inequality in digitalized primary schools in 3T regions appears in unequal internet access, device availability, electricity, family support, pedagogical interaction, and learning outcomes. This study emphasizes the need for contextual, gradual, and needs-based digitalization strategies so that school digitalization strengthens the learning ecosystem rather than merely distributing technological devices.

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1. INTRODUCTION

Digital education has become a major policy priority in many countries, particularly after the COVID-19 pandemic pushed education systems to adapt to technology-based learning (World Bank, 2020). In Indonesia, educational digitalization faces complex challenges because of the country's archipelagic geography, uneven infrastructure quality, and unequal access across regions (Badan Pusat Statistik, 2021). These challenges become more pronounced when digitalization is implemented in disadvantaged, frontier, and outermost regions, commonly referred to as 3T regions, where access to technology, internet connectivity, and adequate educational services remains limited (Kementerian Pendidikan dan Kebudayaan, 2019; UNICEF, 2021).

School digitalization policy in Indonesia gained stronger attention through digital school initiatives and BOS Afirmasi support, which were directed toward expanding educational access in 3T

regions (Kementerian Pendidikan dan Kebudayaan, 2019). These initiatives include the provision of information and communication technology (ICT) facilities, learning devices, and support for schools to access digital learning. Dapodik Kemendikbud (2023) indicates an expansion of digitalization assistance for schools in 3T regions. Nevertheless, the distribution of devices does not automatically guarantee equality in learning outcomes because the success of digitalization is strongly influenced by infrastructure readiness, teachers' competence, household socio-economic conditions, and school institutional capacity (Aisyah & Rahman, 2024).

In the context of educational digitalization, learning inequality refers to differences in access, learning processes, learning experiences, and learning outcomes that emerge because of unequal capacities among students, teachers, schools, and families in using digital technology. This concept is closely related to the digital divide, which includes differences in access, skills, use, and outcomes of digital technology across individuals and social groups (Van Dijk, 2020). The digital divide is not limited to device ownership and internet access; it also includes digital literacy, teachers' pedagogical capacity, the quality of learning content, and support from the learning environment (OECD, 2015; UNESCO, 2021)

At the primary school level, digitalization becomes more complex because students still require intensive guidance, direct pedagogical interaction, and learning media that match their cognitive, social, and emotional development (Piaget, 1950). When digital learning is implemented in areas with limited networks, unstable electricity, inadequate devices, and weak family support, primary school students may face greater learning barriers than students at higher levels of education. This situation shows that digitalization in primary education in 3T regions should be analyzed not only as a technology policy, but also as an issue of educational equity.

3T regions have diverse geographical, social, economic, and institutional characteristics, making uniform educational policy implementation problematic. (Badan Perencanaan Pembangunan Nasional, 2023a) shows that 3T regions still face structural problems such as limited infrastructure, transportation, basic services, and the availability of qualified teachers. Rahayu & Wirza (2020) also found that schools in remote areas face barriers such as limited internet access, a lack of technological devices, and low digital literacy among teachers and students. From the perspective of learning ecology, students' learning conditions are shaped by interactions among families, schools, communities, and government policy (Bronfenbrenner, 1979).

Existing studies on educational digitalization have widely discussed technology use, online learning, and the digital divide. However, systematic evidence on how school digitalization policy affects learning inequality in primary schools located in 3T regions remains limited. Some studies focus on digital learning in general, while others discuss secondary education or urban contexts. Therefore, a systematic literature review is needed to connect school digitalization policy, the digital divide, and learning inequality in primary education in 3T regions.

This study contributes by synthesizing empirical findings and policy-based evidence from 2015 to 2025 to understand the paradox of educational digitalization. Digitalization that is intended to expand access and reduce inequality may instead widen gaps when implemented in schools with low local readiness. Accordingly, this study does not merely assess the importance of educational digitalization; it examines how school digitalization policy can reduce or reproduce learning inequality when applied in regions with limited infrastructure, teacher capacity, household access, and educational ecosystem support.

Specifically, this study addresses the following four research questions.

RQ1 : What forms of learning inequality emerge from the implementation of school digitalization policy in primary schools in Indonesia's 3T regions?

RQ2 : What infrastructural, pedagogical, socio-economic, and school-institutional factors contribute to learning inequality in the digitalization of primary education in 3T regions?

RQ3 : To what extent is school digitalization policy effective in reducing or reproducing learning inequality in primary schools in Indonesia's 3T regions?

RQ4 : What context-based mitigation strategies can support more equitable digital learning in primary schools in 3T regions?

2. METHOD

This study employed a systematic literature review incorporating grey literature to synthesize empirical and policy-based evidence on the relationship between school digitalization policy and learning inequality in primary schools located in Indonesia's 3T regions. A systematic literature review was selected because it enables researchers to identify, select, assess, and synthesize research findings in a structured, transparent, and traceable manner (Kitchenham, 2004; Tranfield et al., 2003). The integration of grey literature is relevant because school digitalization in 3T regions is discussed not only in academic journal articles, but also in selected conference papers, official government reports, policy documents, and reports from international organizations related to the implementation of digital education policy (Paez, 2017).

The reporting procedure followed PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure that identification, screening, eligibility assessment, and inclusion of sources were conducted systematically and transparently (Page et al., 2021). Kitchenham (2004) guideline was also used as a reference in designing the review stages, especially in formulating the search strategy, determining inclusion and exclusion criteria, conducting source quality appraisal, and synthesizing findings.

2.1 Data Sources and Search Strategy

The literature search was conducted through several databases and academic search engines, namely Google Scholar, SINTA, DOAJ, and open-access Scopus-indexed sources. These databases were selected because they contain national and international publications relevant to education, education policy, learning technology, 3T regions, and learning inequality. In addition to academic journal articles, this study considered selected conference papers and official reports directly related to digital education policy in Indonesia.

The keywords used consisted of English and Indonesian search terms. English keywords included 'school digitalization', 'school digitization policy', 'education policy', '3T regions', 'remote areas', 'frontier areas', 'underdeveloped regions', 'learning inequality', 'learning gap', 'digital divide', and 'rural primary schools'. Indonesian keywords included *'digitalisasi sekolah'*, *'kebijakan digitalisasi pendidikan*', *'wilayah 3T*', *'daerah tertinggal'*, *'daerah terdepan'*, *'daerah terluar'*, *'ketimpangan belajar'*, *'kesenjangan digital'*, *'pembelajaran digital'*, and *'sekolah dasar daerah terpencil'*. Bilingual keywords were used to broaden the search coverage because studies on Indonesia's 3T regions are published in both Indonesian and English.

2.2 Inclusion and Exclusion Criteria

Inclusion and exclusion criteria were established to ensure that the sources analyzed were directly relevant to the research focus. Included sources were publications from 2015 to 2025, written in Indonesian or English, available in full text, and discussing school digitalization, digital learning, digital education policy, the digital divide, learning inequality, or primary education in 3T regions, remote areas, rural areas, or regions with infrastructure limitations. Sources that were not relevant to educational digitalization, learning inequality, or the primary education context were excluded from the analysis.

Table 1. Article Inclusion and Exclusion Criteria

Aspect	Inclusion Criteria	Exclusion Criteria
Publication period	Publications from 2015-2025	Publications before 2015
Source type	Peer-reviewed journal articles, selected conference papers, and official research reports or grey literature	Opinion pieces, editorials, popular news, blogs, and non-academic writing
Language	Indonesian or English	Languages other than Indonesian and English
Access	Available in full text	Full text not available

Study focus	School digitalization, digital learning, digital education policy, digital divide, learning inequality, 3T regions, remote areas, or rural areas	Not relevant to educational digitalization, learning inequality, or digital divide
Education context	Primary education, with priority on primary schools	Higher education or other levels without relevance to primary education
Policy relevance	Contains data, findings, or analysis related to digital education policy implementation	No relation to school digitalization policy or practice

2.3 Literature Selection Procedure and PRISMA Flow

The literature selection process followed four main PRISMA stages: identification, screening, eligibility assessment, and final inclusion. At the identification stage, 132 potential sources were obtained, consisting of 100 sources from Google Scholar and SINTA and 32 sources from Scopus and DOAJ. After the initial checking process, 78 sources were removed because they were duplicates or did not meet the preliminary fit with the search focus. Therefore, 54 sources proceeded to the screening stage.

At the screening stage, 54 sources were examined based on titles, abstracts, keywords, and preliminary alignment with the inclusion criteria. From this stage, 34 sources were considered eligible for full-text review. At the eligibility stage, the full texts of these 34 sources were read to ensure substantive alignment with the research focus. Fourteen sources were excluded because they did not directly discuss primary education, were not relevant to learning inequality, lacked sufficient data or findings for synthesis, or had no clear connection with school digitalization. After the selection process, 20 final sources met the inclusion criteria and were used as the basis of analysis in this study.

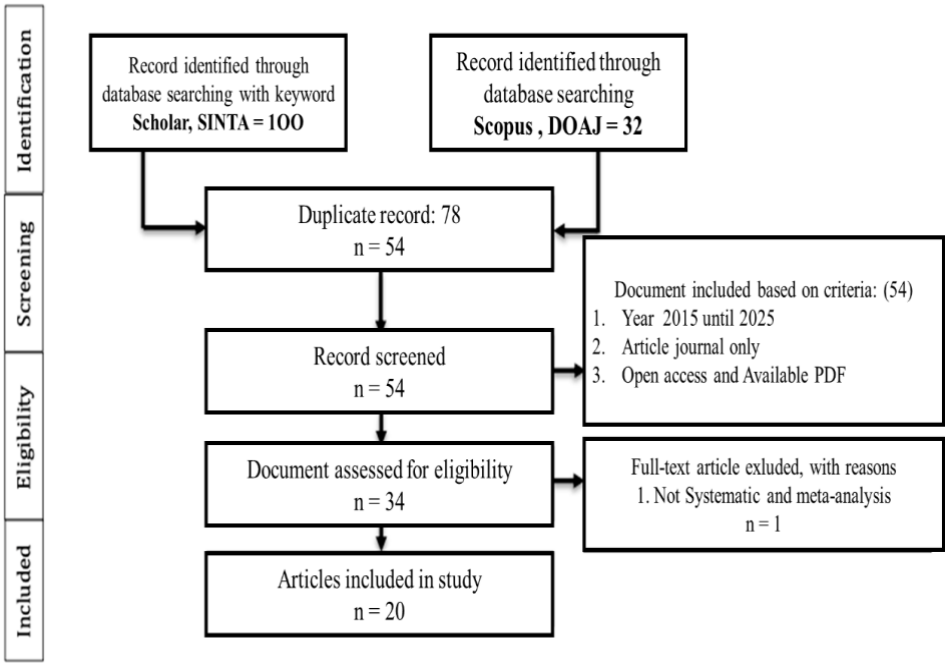

Figure 1. PRISMA Flow Diagram of the Systematic Literature Review

2.4 Quality Appraisal and Risk of Bias Assessment

To strengthen the validity of the synthesis and address potential bias in source selection, this study applied quality appraisal and risk of bias assessment to all sources that passed the eligibility stage. Quality appraisal was used to ensure that each source had clear objectives, appropriate methods, relevant contexts, and sufficient contribution to the synthesis. This step was particularly important because the review included not only peer-reviewed journal articles, but also selected conference papers and official reports as grey literature.

Quality appraisal was conducted using an operational rubric developed for this study by referring to principles of quality appraisal in systematic literature reviews and grey literature evaluation. The rubric assessed the clarity of research or review objectives, methodological appropriateness, contextual clarity, source credibility, relevance to school digitalization, relevance to learning inequality, clarity of key findings, and policy relevance for primary education in 3T regions (Kitchenham, 2004; Paez, 2017; Page et al., 2021 ; Tranfield et al., 2003). Each indicator was scored from 0 to 2. A score of 0 indicated that the aspect was not fulfilled or not explained, a score of 1 indicated that the aspect was explained only partially, and a score of 2 indicated that the aspect was clearly and adequately explained. This scoring scheme adapts a common quality assessment logic in systematic reviews using the categories not fulfilled, partially fulfilled, and fully fulfilled. The maximum total score was 16. Sources with scores of 13-16 were categorized as high quality, scores of 9-12 as moderate quality, and scores of 8 or below as low quality.

Table 2. Source Quality Appraisal Indicators

Code	Quality Appraisal Indicator	Score
QA1	Clarity of research or review objective	0-2
QA2	Appropriateness of method to the objective	0-2
QA3	Clarity of location, regional, or educational context	0-2
QA4	Credibility of source type and data transparency	0-2
QA5	Relevance to school digitalization or digital learning	0-2
QA6	Relevance to learning inequality, digital divide, or educational equity	0-2
QA7	Clarity of key findings and contribution to synthesis	0-2
QA8	Policy relevance to primary education and 3T regions	0-2
Total	Maximum score	16

Risk of bias assessment considered five potential forms of bias: selection bias, publication bias, contextual bias, reporting bias, and source-quality bias. Selection bias was controlled through explicit inclusion and exclusion criteria. Publication bias was reduced by including relevant grey literature, especially official government and international organization reports, so that the synthesis did not rely solely on published journal articles. Contextual bias was controlled by distinguishing sources that directly addressed 3T or remote areas from sources that discussed educational digitalization more generally. Reporting bias was reduced through a standardized data extraction matrix. Source-quality bias was controlled by assigning quality scores and using moderate- to high-quality sources as the main basis for synthesis.

Table 3. Summary of Quality Appraisal Results for the 20 Sources Analyzed

No.	Source	Source Type	Total Score	Quality Category	Risk of Bias	Status
1	Aisyah & Rahman, (2024)	Journal article	15/16	High	Low	Included
2	Rahayu & Wirza (2020)	Journal article	15/16	High	Low	Included
3	Hayati & Sari (2023)	Journal article	16/16	High	Low	Included
4	Sedatiwara et al. (2023)	Article/literature study	15/16	High	Low	Included
5	Puspitoningrum et al. (2024)	Journal article	15/16	High	Low	Included
6	Haq et al. (2023)	Journal article	12/16	Moderate	Moderate	Included
7	Sinambela et al. (2024)	Journal article	13/16	High	Moderate	Included
8	Dewi (2020)	Journal article	12/16	Moderate	Moderate	Included
9	Apriyenti et al. (2024)	Journal article	12/16	Moderate	Moderate	Included
10	Putra (2023)	SLR article	12/16	Moderate	Moderate	Included
11	Kementerian Pendidikan dan Kebudayaan (2019)	Official report/grey literature	14/16	High	Moderate	Included
12	Dapodik Kemendikbud (2023)	Official data/grey literature	14/16	High	Moderate	Included
13	Badan Perencanaan Pembangunan Nasional (2023)	Official report/grey literature	14/16	High	Moderate	Included

14	UNICEF (2021)	Official report/grey literature	15/16	High	Low	Included
15	World Bank (2022)	Official report/grey literature	14/16	High	Low	Included
16	Gudmundsdottir & Hatlevik, (2018)	Journal article	12/16	Moderate	Moderate	Included
17	Tondeur et al. (2017)	Systematic review article	12/16	Moderate	Moderate	Included
18	Wang & Zhang (2024)	Journal article	12/16	Moderate	Moderate	Included
19	Sepadi et al. (2025)	Journal article	11/16	Moderate	Moderate	Included
20	(Li, 2025)	Journal article	12/16	Moderate	Moderate	Included

Note: Scores of 13-16 were categorized as high, scores of 9-12 as moderate, and scores of 8 or below as low. All analyzed sources obtained a minimum score of 9 and were therefore retained in the synthesis.

2.5 Data Extraction

Data from the 20 included sources were extracted using a literature extraction matrix. This matrix ensured that each claim in the findings and discussion had a clear basis in the analyzed sources. The extracted information included author and year, source type, method or study design, location or research context, education level, digitalization focus, key findings, forms of learning inequality, and relevance to the research questions.

Table 4. Methodological Characteristics of Included Sources

No.	Source	Source Type	Method/Design	Location/Context	Education Level
1	Aisyah & Rahman (2024)	Journal article	Empirical/policy study	Frontier areas in Indonesia	Primary education
2	Rahayu & Wirza (2020)	Journal article	Case study/qualitative	Remote areas in Indonesia	Primary education
3	Hayati & Sari (2023)	Journal article	Empirical/qualitative study	Remote primary schools	Primary school
4	Sedatiwara et al. (2023)	Article/literature study	Literature study	Primary schools in 3T regions after the pandemic	Primary school
5	Puspitoningrum et al. (2024)	Journal article	Case study	Primary schools	Primary education
6	Haq et al. (2023)	Journal article	Case study/qualitative	Resource-limited primary schools	Primary school
7	Sinambela et al. (2024)	Journal article	Conceptual/literature study	Indonesian education context	General education
8	Dewi (2020)	Journal article	Empirical/literature study	Online learning during COVID-19	Primary school
9	Apriyenti et al. (2024)	Journal article	Literature study	Indonesian education	General education
10	Putra et al. (2024)	SLR article	Systematic literature review	General education	General education
11	Kementerian Pendidikan dan Kebudayaan (2019)	Official report/grey literature	Policy document	Indonesia, especially 3T areas	School
12	Dapodik Kemendikbud (2023)	Official data/grey literature	Administrative data	Schools in Indonesia's 3T regions	School
13	Badan Perencanaan Pembangunan	Official report/grey literature	Policy report	Indonesia's 3T regions	Education and regional development

	Nasional (2023)				
14	UNICEF (2021)	Official report/grey literature	Assessment report	Indonesia	Children and schools
15	World Bank (2022)	Official report/grey literature	Education policy/analytical report	Indonesia	Primary and secondary education
16	Gudmundsdottir & Hatlevik (2018)	Journal article	Empirical study	Teacher education	Teachers/ schools
17	Tondeur et al. (2017)	Systematic review article	Systematic review	International education	Teachers/ schools
18	Wang & Zhang (2024)	Journal article	Empirical study	Rural schools	Teachers/schools
19	Sepadi et al. (2025)	Journal article	Empirical/qualitative study	Rural schools	Teachers/ schools
20	Li (2025)	Journal article	Comparative study	Urban and rural teachers	Primary education

Table 5. Thematic Extraction and Relevance to Research Questions

No.	Source	Digitalization Focus	Key Findings	Dimension of Learning Inequality	RQ
1	Aisyah & Rahman (2024)	Digital divide in primary education	Digitalization has not fully reduced gaps because access to technology, internet, and user readiness remain uneven.	Infrastructure access, devices, and digital learning participation	RQ1, RQ2, RQ3
2	Rahayu & Wirza (2020)	Digital transformation in remote areas	Remote schools face weak connectivity, limited devices, and low digital literacy.	Internet access, teacher capacity, and school readiness	RQ1, RQ2, RQ4
3	Hayati & Sari (2023)	Digital learning in remote primary schools	Digital learning effectiveness is influenced by infrastructure readiness, teacher support, and the suitability of technology for primary students.	Access, learning quality, and pedagogical support	RQ1, RQ2, RQ4
4	Sedatiwara et al. (2023)	Online learning in 3T regions	Online learning can operate when supported by devices, networks, teacher competence, parental involvement, and alternative media.	Online access, family support, and learning effectiveness	RQ2, RQ3, RQ4
5	Puspitoningrum et al. (2024)	Digital learning platforms	Digital platforms can improve learning experiences, but their effectiveness depends on teacher readiness, devices, and the school environment.	Platform use, teacher competence, and content quality	RQ2, RQ3

6	Haq et al. (2023)	Digital-based educational transformation	Digital transformation in primary schools faces challenges in human resource readiness, device availability, teacher training, mentoring, and school collaboration.	School capacity, teacher competence, and digital learning quality	RQ2, RQ3
7	Sinambela et al. (2024)	Educational digital divide	The digital divide includes access to devices, internet, and the ability to use technology for learning.	Household access, digital literacy, and learning opportunity	RQ1, RQ2
8	Dewi (2020)	Online learning in primary schools	Online learning in primary schools faces challenges related to internet access, teacher readiness, parental involvement, and student adaptation.	Online participation, household access, and parental support	RQ2, RQ3
9	Apriyenti et al. (2024)	Digitalization for accessibility and inclusion	Digitalization can improve access, but it may also widen gaps without affirmative policies.	Access, quality, and educational inclusion	RQ1, RQ3, RQ4
10	Putra et al. (2024)	Urgency of digital technology	Digital technology supports flexibility and personalization, but effectiveness depends on ecosystem readiness.	Quality of technology use and user readiness	RQ3, RQ4
11	Kementerian Pendidikan dan Kebudayaan (2019)	Digital schools and BOS Afirmasi	The government promotes 3T education access through ICT facilities and digital school policy support.	Gap between policy, assistance, and local readiness	RQ3, RQ4
12	Dapodik Kemendikbud (2023)	Digitalization assistance distribution	Assistance distribution indicates expanded access, but it does not automatically prove learning effectiveness.	Assistance access, school readiness, and learning outcomes	RQ1, RQ3
13	Badan Perencanaan Pembangunan Nasional (2023)	3T regional development	3T regions continue to face infrastructure, connectivity, basic service, and human resource barriers.	Regional structural inequality and digital learning quality	RQ1, RQ2, RQ4
14	UNICEF (2021)	Digital learning landscape	Digital learning faces barriers in access, devices, connectivity, and learning support, especially for vulnerable children.	Digital access, learning engagement, and environmental support	RQ1, RQ2, RQ4
15	World Bank (2022)	Learning poverty and learning recovery	Learning lag is worsened by learning disruption and limited	Learning outcomes, learning loss, and	RQ1, RQ3

			access to education services.	access to education services	
16	Gudmundsdottir & Hatlevik (2018)	Teachers' digital competence	Teachers' digital competence determines the success of technology integration in learning.	Pedagogical inequality and teacher capacity	RQ2, RQ4
17	Tondeur et al. (2017)	Pedagogical beliefs and technology	Technology use is influenced by pedagogical beliefs, teacher readiness, and learning design.	Quality of technology use and pedagogical transformation	RQ2, RQ4
18	Wang & Zhang (2024)	Rural teachers' digital competence	Rural teachers face barriers related to training, technology access, and institutional support.	Teacher competence and professional support	RQ2, RQ4
19	Sepadi et al. (2025)	Technology use in rural schools	Teachers' understanding of technology is influenced by access, experience, training, and school conditions.	Teacher capacity and school institutional readiness	RQ2, RQ4
20	Li (2025)	TPACK and technology integration	There are differences in technological-pedagogical competence between urban and rural teachers.	Teachers' digital competence, TPACK, and learning quality	RQ2, RQ4

Note: RQ1 = forms of learning inequality in school digitalization implementation; RQ2 = contributing factors to learning inequality; RQ3 = effectiveness of school digitalization policy in reducing or reproducing inequality; RQ4 = context-based mitigation strategies for 3T regions.

2.6 Data Synthesis

The data were synthesized thematically because the analyzed sources varied in methods, data types, research contexts, and outcome measures. Therefore, this study did not use quantitative meta-analysis. Thematic synthesis was selected to identify major patterns emerging from the sources, particularly patterns related to the relationship between school digitalization and learning inequality in primary education in 3T regions.

The synthesis involved reading all eligible sources, identifying initial themes such as internet access, electricity, device ownership, teachers' digital competence, parental support, content quality, school management, and policy support, grouping these themes into broader analytical categories, and mapping them onto the research questions.

The thematic synthesis was organized into four themes: forms of learning inequality, contributing factors, policy effectiveness in reducing or reproducing inequality, and context-based mitigation strategies such as hybrid learning, offline digital technology, printed modules, educational radio, community collaboration, and continuous teacher training.

3. FINDINGS AND DISCUSSION

3.1 Findings

Based on the synthesis of 20 sources that passed the selection, quality appraisal, and data extraction processes, this study finds that school digitalization policy in 3T regions has a dual effect on learning inequality at the primary school level. On the one hand, digitalization opens opportunities to expand access to learning resources, increase learning flexibility, and strengthen pedagogical

innovation. On the other hand, digitalization can reproduce and even widen learning inequality when implemented in regions with limited infrastructure, low teachers' digital competence, weak family support, and uneven school managerial capacity. This condition reflects a digitalization paradox, namely a situation in which policies intended to reduce educational inequality may generate new inequalities if they are not accompanied by adequate educational ecosystem readiness

3.1.1 Forms of Learning Inequality in Primary School Digitalization in 3T Regions

The first finding shows that learning inequality in the digitalization of primary schools in 3T regions is not limited to unequal access to digital devices. It also includes inequality in connectivity, electricity, home learning access, the quality of learning interaction, and the relevance of digital content to students' needs. In 3T regions, school digitalization often encounters unstable basic infrastructure. Schools may receive devices or digital platforms, but their use in learning remains limited when internet networks are unavailable, electricity is unstable, or technical support is inadequate. This condition indicates that access to technology is not identical to access to quality digital learning.

Infrastructure access is the most dominant form of inequality. Rahayu and Wirza (2020), Hayati and Sari (2023), and UNICEF (2021) show that schools in remote areas face major barriers, including weak internet connectivity, limited devices, and low technical readiness. In the primary school context, these barriers become more serious because students still need direct guidance, intensive pedagogical interaction, and learning media that are appropriate for their cognitive and socio-emotional development.

Inequality also emerges at the household level. Students living in families with internet access, personal devices, and parental support have greater opportunities to benefit from digital learning. In contrast, students from low-income families or those living in areas with limited network access face layered barriers. Dewi (2020) and Sinambela et al. (2024) show that digital learning reveals differences in learning opportunities between students who have devices and family support and students who do not.

Another form of inequality concerns learning content and pedagogical interaction. Puspitoningrum et al. (2024) show that digital learning platforms can improve learning experiences when supported by appropriate learning design. However, in many schools with limited resources, technology tends to be used substitutively, merely replacing printed materials or face-to-face instruction without transforming pedagogical interaction. As a result, digitalization does not automatically improve learning quality when content, methods, and learning interaction are not developed contextually.

Thus, learning inequality in primary school digitalization in 3T regions can be summarized into five main dimensions: infrastructure inequality, household access inequality, digital competence inequality, learning content inequality, and learning outcome inequality. These dimensions are interconnected and create cumulative barriers for students in 3T regions. This finding answers RQ1 by showing that school digitalization produces not only technical gaps, but also pedagogical and social gaps that directly affect students' learning opportunities.

3.1.2 Factors Contributing to Learning Inequality

The second finding shows that learning inequality in the digitalization of primary education in 3T regions is influenced by four main groups of factors: infrastructure, pedagogy, socio-economic conditions, and school institutional capacity. These factors do not operate separately; instead, they reinforce one another. Schools with limited infrastructure tend to face barriers in using digital platforms; teachers with low digital competence struggle to design technology-based learning; students with limited family support struggle to participate in digital learning; and schools with weak managerial capacity often fail to sustain digitalization programs.

Infrastructure is the most basic prerequisite. Internet networks, electricity, learning devices, and technical support determine whether digitalization policy can be implemented effectively. Rahayu and Wirza (2020), Badan Perencanaan Pembangunan Nasional (2023), and UNICEF (2021) emphasize that 3T regions still face structural barriers related to connectivity, transportation, and basic services. Under

such conditions, digitalization policies that focus only on device distribution without improving the infrastructure ecosystem risk creating implementation gaps.

Pedagogical factors concern teachers' digital competence and their ability to integrate technology into learning. Gudmundsdottir and Hatlevik (2018), Tondeur et al. (2017), and Wang and Zhang (2024) show that teachers' digital competence includes not only technical skills in operating devices, but also pedagogical skills in selecting media, designing learning activities, providing feedback, and adapting technology to students' characteristics. In primary schools in 3T regions, this competence is crucial because students are not yet fully independent in using technology.

Socio-economic factors also contribute significantly to learning inequality. Students from vulnerable families face barriers such as lack of personal devices, the cost of internet data, limited learning space at home, and limited parental capacity to support digital learning. Dewi (2020) and Sinambela et al. (2024) demonstrate that online or digital learning can strengthen differences in learning opportunities when household support is uneven.

School institutional factors include leadership, coordination, device management, learning planning, and program sustainability. Puspitoningrum et al. (2024) show that schools with management support, trained teachers, and clear implementation strategies tend to achieve better results than schools that only receive devices. This finding indicates that the effectiveness of digitalization should not be measured solely by the number of devices or assistance received, but by the school's capacity to manage, maintain, and integrate technology into the learning process.

Accordingly, RQ2 can be answered by stating that learning inequality in the digitalization of primary education in 3T regions is shaped by a combination of structural and pedagogical factors. Limited infrastructure creates access barriers, low teacher digital competence constrains learning quality, socio-economic vulnerability widens learning opportunity gaps, and weak school institutional capacity undermines program sustainability.

3.1.3 Effectiveness of School Digitalization Policy in Reducing or Reproducing Inequality

The third finding shows that the effectiveness of school digitalization policy in 3T regions is conditional. Digitalization policy can contribute to educational equity when supported by infrastructure readiness, teacher competence, technical assistance, school leadership, and adaptive implementation strategies. However, policies implemented uniformly without considering differences in local readiness may reproduce learning inequality.

Policy data indicate the government's commitment to expanding access to school digitalization, including through ICT facilities and support programs for schools in 3T regions. Kementerian Pendidikan dan Kebudayaan (2019) positions digital schools as part of the strategy to expand educational access, while Dapodik Kemendikbud (2023) indicates the distribution of digitalization assistance to schools in 3T regions. Nevertheless, findings from various sources show that device distribution is not sufficient to guarantee improved learning quality.

Digitalization appears more effective in schools that meet a minimum readiness threshold, such as the availability of internet connections or offline technological alternatives, adequate teacher training, sustainable device use, and school management support. Puspitoningrum et al. (2024) show that digital platforms can improve learning experiences when teachers use them pedagogically. Sedatiwara et al. (2023) also show that online learning in 3T regions remains possible when supported by collaborative strategies, parental involvement, and alternative media.

Conversely, digitalization can reproduce inequality when policy is designed through a uniform approach. A one-size-fits-all model is not suitable for 3T regions because geographical, social, economic, and infrastructural conditions vary significantly across areas. Schools with stable internet, trained teachers, and parental support will benefit more quickly from digitalization. Meanwhile, schools in areas with limited electricity, weak networks, and minimal mentoring may fall further behind.

This finding answers RQ3 by showing that school digitalization policy has uneven effectiveness. It can reduce inequality when supported by needs-based implementation design, but it can reproduce inequality when it is oriented merely toward the equal distribution of devices. Therefore, the success

of school digitalization should not be measured only by the number of devices, platforms, or recipient schools, but also by the quality of technology use, changes in learning practices, improvements in teacher competence, and effects on students' participation and learning outcomes.

3.1.4 Context-Based Mitigation Strategies for Equitable Digital Learning

The fourth finding shows that strategies to mitigate learning inequality in the digitalization of primary schools in 3T regions must be contextual, gradual, and ecosystem-based. Strategies that emphasize device provision alone are insufficient to address learning inequality. Digitalization in 3T regions requires interventions that consider geographical conditions, infrastructure readiness, teacher capacity, the characteristics of primary school students, family support, and local community involvement.

The first strategy is the implementation of hybrid learning and offline digital technology. In areas with limited connectivity, digital learning should not depend entirely on the internet. Sedatiwara et al. (2023) show that learning in 3T regions can be supported through a combination of face-to-face learning, printed modules, local media, and simple digital technology. Hybrid models allow schools to use technology while still considering access limitations.

The second strategy is the continuous strengthening of teachers' digital competence. Teacher training should not be conducted only once or focus merely on operating devices. Teachers need continuous mentoring in digital learning design, technology-based assessment, interactive media use, and contextual content development. Tondeur et al. (2017) and Gudmundsdottir and Hatlevik (2018) emphasize that the success of educational technology is strongly influenced by pedagogical beliefs, learning design ability, and teachers' professional digital competence.

The third strategy is the development of contextual digital content. Digital learning materials for primary school students in 3T regions should be aligned with students' local experiences, language, culture, and everyday realities. Puspitoningrum et al. (2024) and Hayati and Sari (2023) show that the effectiveness of digital learning depends strongly on the suitability of media and content to students' needs.

The fourth strategy is community-based collaboration. School limitations in 3T regions cannot be addressed by a single institution. Central government, local government, schools, parents, communities, non-governmental organizations, and the private sector need to be involved in building a sustainable digital ecosystem. UNICEF (2021) and Badan Perencanaan Pembangunan Nasional (2023) emphasize the importance of cross-sector support in addressing barriers to access and educational services in vulnerable areas.

The fifth strategy is differentiated digitalization policy based on regional typology. Schools in 3T regions cannot be treated the same as schools in urban areas. The government needs to develop school digital readiness maps that include internet conditions, electricity, devices, teacher capacity, school management, and family support. Based on such maps, interventions can be implemented in stages: fulfilling basic infrastructure, strengthening teacher capacity, providing offline content, developing hybrid models, and conducting learning-outcome-based evaluation.

These findings answer RQ4 by showing that the most relevant mitigation strategies for primary schools in 3T regions are locally contextual strategies. These include hybrid learning, offline technology, continuous teacher training, contextual digital content, community collaboration, and affirmative policies based on regional typology. Through these strategies, digitalization has the potential to become an instrument of educational equity rather than a new source of learning inequality.

3.2 Discussion

The findings of this study indicate that school digitalization in Indonesia's 3T regions should not be understood merely as a technological intervention, but as an educational equity policy. Digitalization can expand access to learning resources, support flexible learning, and create opportunities for pedagogical innovation. However, these benefits are not distributed equally because schools in disadvantaged, frontier, and outermost regions operate within unequal infrastructural, pedagogical, socio-economic, and institutional conditions. This finding confirms the argument that the

digital divide is multidimensional, involving not only access to devices and internet connectivity, but also differences in skills, patterns of use, and educational outcomes (Van Dijk, 2020). Therefore, equal provision of digital devices does not automatically produce equitable learning when schools and students begin from unequal starting points.

Infrastructure remains the most visible barrier in the implementation of school digitalization in 3T regions. Limited internet connectivity, unstable electricity, insufficient devices, and weak technical support restrict schools' ability to integrate digital technology into daily learning practices. Previous studies have shown that remote schools in Indonesia continue to face serious obstacles related to connectivity, device availability, and digital literacy (Rahayu & Wirza, 2020; UNICEF, 2021). These challenges are more significant at the primary school level because young learners require direct guidance, age-appropriate learning media, and intensive pedagogical interaction. Thus, digital access in primary education cannot be reduced to the availability of devices; it must also include reliable infrastructure, meaningful learning support, and continuity of use.

The study also shows that teacher readiness plays a central role in determining whether digitalization reduces or reproduces learning inequality. Teachers' digital competence is not limited to operating devices or platforms; it includes the ability to design meaningful learning activities, select appropriate digital media, provide feedback, and adapt technology to students' developmental needs. This is consistent with previous research showing that teachers' pedagogical beliefs, professional digital competence, and instructional design capacity strongly influence the quality of technology integration in schools (Gudmundsdottir & Hatlevik, 2018; Tondeur et al., 2017). In 3T primary schools, insufficient training and mentoring may cause technology to be used only as a substitute for printed materials rather than as a tool for improving learning interaction.

Household and socio-economic factors further deepen learning inequality in digitalized education. Students from families with stable internet access, personal devices, and parental support have greater opportunities to participate in digital learning. Conversely, students from low-income households or areas with poor connectivity face layered disadvantages, including limited access to devices, internet costs, lack of learning space, and minimal parental assistance. Studies on online learning in primary education show that family support and home learning conditions significantly affect students' participation and learning experiences (Dewi, 2020; Sinambela et al., 2024). This means that school digitalization may unintentionally widen learning gaps when household-level inequalities are not addressed.

These findings suggest that the effectiveness of school digitalization policy depends on local readiness and ecosystem support. Digitalization can reduce inequality when it is implemented contextually, gradually, and accompanied by teacher training, infrastructure improvement, technical assistance, and relevant digital content. However, uniform policies that focus mainly on device distribution risk reproducing inequality because schools in 3T regions have different levels of readiness. Therefore, policy evaluation should move beyond administrative indicators, such as the number of devices distributed or recipient schools, toward indicators related to technology use quality, teacher competence, student participation, and learning outcomes. Context-based mitigation strategies, including hybrid learning, offline digital technology, printed modules, community collaboration, and differentiated policy based on regional typology, are needed to ensure that digitalization strengthens the learning ecosystem rather than creating new forms of exclusion (Badan Perencanaan Pembangunan Nasional, 2023; Sedatiwara et al., 2023).

4. CONCLUSION

Based on a systematic literature review that incorporates grey literature, this study concludes that school digitalization policy in primary schools in Indonesia's 3T regions has a dual effect on learning inequality. On the one hand, digitalization has the potential to expand access to learning resources, increase learning flexibility, and promote pedagogical innovation. On the other hand, these benefits have not been realized equally due to persistent limitations in infrastructure, internet connectivity, electricity, device ownership, teachers' digital competence, family support, and school managerial capacity. Thus, the findings indicate that the effectiveness of school digitalization policy

depend strongly on local readiness and support from the broader educational ecosystem. Uniform policy implementation that overlooks school-level and regional differences may therefore risk reproducing learning inequality.

The main contribution of this study is to emphasize that school digitalization should not only be understood merely as the distribution of devices or the expansion of recipient schools, but as an effort to improve the quality of technology use, teacher competence, student participation, and the reduction of learning outcome gaps. In practical terms, digitalization policy in 3T regions should be implemented contextually, gradually, and according to regional needs through hybrid learning, offline digital technology, contextual learning content, continuous teacher training, community collaboration, and affirmative policies based on the typology of 3T regions. Given that this study is limited by its reliance on secondary sources with diverse methods, contexts, and outcome measures, future research is recommended to employ longitudinal empirical designs or school-based action research to test digitalization models that are more adaptive to the social, geographical, and infrastructural conditions of 3T regions.

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