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Rural Educators' Lo-Tech Resiliency Pedagogy: Insights from Eastern Indoensia

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ABSTRACT: This study illustrates how seven female rural school teachers in Papua utilize Lo-Tech solutions as a resilience pedagogy in environments with limited infrastructure. Employing a qualitative approach, data were collected through in-depth interviews, focus group discussions, content analysis, and teacher reflection notes. The study revealed that teachers implement four pedagogical stages: planning, implementation, monitoring, evaluation, and reflection. This approach positively impacts student outcomes, with evaluations contributing to student engagement, social relationships, and inclusivity. However, this study has limitations, such as the small number of participants, the focus on female teachers, and the absence of classroom intervention, which should be addressed in future research. The study offers several insights and recommendations such as: (1) The government should reduce educators' administrative burdens, allowing them to focus on pedagogy. (2) Both low- and high-tech solutions should be integrated into teaching and learning. (3) Continuous educator training on a weekly, monthly, and semester. (4) High-voltage electricity should be provided to ensure 24/7 availability of the system. (5) Parental involvement and community engagement are vital, as rural schools in Papua cannot thrive without the support of local communities, village leaders, and religious leaders working together to advance education.

KEYWORDS: Lo-Tech, inclusive education, resilience-pedaggoy strategy, rural area, rural schooling, teacher agency

INTRODUCTION

"Even though I live in a rural area with limited Wi-Fi access, I am determined to make progress," asserted a rural educator. This statement underscores that inadequate infrastructure should not hinder educational innovations. In line with this belief, a study was conducted to support teaching and learning in rural Indonesia, where infrastructure and Internet connectivity are limited, by utilizing Lo-Tech solutions. Lo-Tech refers to the use of simple and easily accessible technology as a medium for learning. It is characterized by its ease of use, requiring neither advanced technological content knowledge (TCK) nor a strong Wi-Fi connection, and can function offline. Despite its simplicity, it has a significant impact on rural education (Asamoah, 2021; Butarbutar, 2024 a, b. Davis et al., 2023; Kuznetcova et al., 2025; Tanguy et al., 2023).

In rural educational contexts, Lo-Tech refers to the utilization of basic technology to deliver educational materials to students, taking into account the local context and needs. This approach aligns with the theory of appropriate technology, which emphasizes the suitability of technology to local conditions, as well as the literature on low-resource pedagogy, which views simple technology as a realistic strategy to support learning in areas with limited resources (Lin et al., 2025) (Suppiah Shanmugam et al., 2025).

This study examines the implementation of Lo-Tech strategies as survival pedagogy for teaching in rural Indonesia, acknowledging that these are not novel technologies. Educators utilized WhatsApp Groups (WAG) as a medium for disseminating learning materials, monitoring student attendance, and facilitating homework submission. Additionally, teachers employed personal laptops to manage administrative tasks such as developing lesson plans and syllabi. To assist in the preparation and sourcing of educational materials, teachers frequently accessed information from the Internet, including Google and YouTube. These materials were recorded and subsequently presented to the students without requiring an Internet connection. Occasionally, PowerPoint presentations were used to elucidate supplementary materials.

Papuan rural schools have been thoroughly examined. (Ardiningtyas et al., 2023) and (Butarbutar et al., 2023, Butarbutar, 2025a, b, c), assert that combining synchronous and asynchronous learning can enhance students' EFL speaking skills. They advocate for educators in rural areas to use voice note WhatsApp feature to improve students' pronunciation abilities. They concluded that an online collaborative learning curriculum is an effective teaching method in rural university settings. Fredy et al. (2019) also emphasize that problem-based learning can enhance students' science skills in rural primary school contexts. Additionally, local culture-based puzzles boost motivation, interest, and confidence in young English learners (Butarbutar et al., 2019), (Uspayanti et al., 2021). Fiharsono et al. (2025) proposed a strategy for inclusive education in rural schools in Papua by integrating traditional education, involving the community, and utilizing the local language. In 2024, Fiharsono et al. explored a new pedagogy for the indigenous Korowai tribe, focusing on the school physical environment based on local cultural practices. Lestari

& Gunawan (2020), Parker and Sudibyo (2024) identified socio-economy and social welfare as the main reasons for young Papuan people leaving or dropping out of school, despite the government program mandating 12 years of learning.

While rural education issues have been previously explored, the focus has primarily been on socioeconomic factors and new pedagogical approaches rooted in local culture for teaching Papuan indigenous people. However, no research has addressed the issues of low technology. Furthermore, there is a lack of literature that explicitly conceptualizes Lo-tech designed specifically for the Papuan context, where technology is not merely innovation but also a form of resilient pedagogy.

In contrast to previous investigations, the current study delves into the complexities of Papuan rural education, which extend far beyond the use of Lo-Tech solutions. Many students arrive at school lacking literacy skills and are unable to read or write properly. The availability of student books is limited, and only a few students can afford to purchase them. Student absenteeism is often influenced by socioeconomic factors and a lack of parental support. Teachers face the challenge of managing large classes with a wide range of students abilities and learning needs. In this context, task-based learning has emerged as the primary strategy, with educational assessments given to students who fail to complete their assignments. The pedagogical gap is further complicated by teacher absences due to personal issues.

Furthermore, this study addresses existing research gaps by thoroughly examining the implementation of learning in rural schools in Papua and developing a framework that is Lo-Tech, contextual, realistic, flexible, and aligned with real-world situations. Theoretically, it advances the understanding of adaptive learning design in low-resource environments. Practically, it provides teachers with a direct strategy to design inclusively, narrow the pedagogical gap, and optimize Lo-Tech resources. This approach can act as a bridge to promote equity, resilience, and inclusive education.

To conceptually complete the current study, this research defines "rural area" as a geographical location distinct from urban or coastal regions (KBBI [Indonesian Online Dictionary]). However, within the context of this study, it is defined not only as being geographically separate from urban areas but also as educational regions characterized by underserved infrastructure, digital resources, and social resources, which practically impact learning. From a Lo-Tech perspective, rural areas are school environments that have overcome challenges such as unstable Internet, weather-dependent signals, and limited digital technology and competency. Teachers and students are not accustomed to high technology, lack digital skills for learning, and rarely have personal computers to support educational activities. Additionally, the motivation to use technology for learning purposes is low because technology is not a part of their daily routine. Therefore, rural areas imply education with Lo-Tech and limited facilities, where Lo-Tech serves as resilience pedagogy (Butarbutar et al., 2023).

Research design

The current study aims to address three research questions: (1) how is Lo-Tech implemented, (2) what impact does it have on students' outcomes, and (3) how do teachers perceive its use in rural Papuan schools. This study is contextual and complex, necessitating an in-depth understanding of human experience and real-world situations. The qualitative approach allows researchers to capture processes, dynamics, and meanings that cannot be reduced to numerical values. Specifically, leveraging Lo-Tech in Papuan rural schools represents a new resilience pedagogy that has not been previously explored from the socio-pedagogical and inclusiveness perspectives. The qualitative case study approach was selected to thoroughly understand teachers' perceptions and their strategies for addressing underserved technology, as recommended by Creswell and Poth (2016), who argued that a case study qualitative approach focusing on experiences and processes is not statistical in nature.

Furthermore, the case study was selected because it provided a rich and comprehensive understanding of the Lo-Tech concept and contributed to the body of knowledge at a low cost (Yin, 2014; Stake, 1995).

Case study of school 1:

Data from School 1 were categorized as follows: **(1) Teachers**: There were 10 teachers, with six also serving as class supervisors for classes 1 through 6. The staff includes one English teacher, one religion teacher, one physic or sports teacher, and a headmaster, all of whom hold undergraduate certifications.

(2) Students: The student body comprised 209 individuals from middle- to low-income backgrounds. As a government school, students are not required to pay tuition fees. **(3) Facilities**: Since August 2025, schools have provided free lunches to students. Although there is a school library, it has a limited selection of books and is also used to support students with low literacy during extra time. The school lacks transportation services; therefore, some students are dropped off by their parents, while others walk. Instead of a workbook, a student book is provided for one semester, costing around twenty thousand IDR, which not all students can afford. The school has one computer for administrative tasks and another for the headmaster, along with a printer for school administration, which frequently malfunctions due to empty ink and overload errors during the printing of final exams.

Case study of school 2:

The data collected from School 2 can be categorized as follows: **(1) Teachers:** School 2 employs nine teachers, all of whom hold undergraduate certifications. There is no designated English teacher; therefore, the class advisor also assumes the role of the English teacher. As a result, they frequently download materials and videos from the Internet and YouTube to teach basic English at the elementary level. To prepare teaching materials, such as syllabi, they rely on their own laptops. Teacher inconsistency in the classroom sometimes arises due to school meetings and personal issues. **(2) Students:** The school has 198 students, most of whom come from low-income families. Some students arrive at school barefoot, having walked from their homes, and enter the classroom without learning tools like books and pencils, bringing only themselves. **(3) Facilities:** School 2 lacks a library, resulting in no reading resources or workbooks to support literacy and numeracy in the school. However, teachers address this by displaying letters and numbers on classroom walls. There is only one computer available for administrative tasks and another for the headmaster's use. A single projector is shared for school meetings and classroom teaching, necessitating rotation among different classes.

Both schools are different regarding numbers of students and teachers, facilities, and students socio-economy background. While, the similarity is location in the rural areas and leveraging Lo-Tech to support teaching and learning materilas.

Data collection and participants' profile

The current study involved seven female primary or elementary teachers, all under the age of 30. One of them, Teacher 1, has over 10 years of experience as a primary school teacher and is currently pursuing a master's degree through an online distance learning program. Teacher 2 serves as a class advisor for grade three and also teaches English to students in grades four to six at School 2, where English lessons are offered from grade 4 to 6. She frequently participates in teacher training to enhance her skills, particularly in utilizing technology within the EFL context. Additionally, she conducts extra classes in the library to support her students with English literacy or engage them in word puzzles during their free time. Teacher 3 is a class advisor for grade 2, while Teacher 4 advises grade 4, Teacher 5 advises grade 1, and Teacher 6 advises grade six. All of them possessed personal laptops for teaching purposes. They also used a WhatsApp Group (WAG) for learning and communicating with parents. Finally, teachers used PowerPoint as a learning medium to deliver materials and YouTube as a learning source.

To collect data, we employed in-depth interviews, Focus Group Discussions (FGD), content analysis of students' report sheets, and teachers' reflection notes. Interviews were conducted to delve into teachers' experiences with Lo-Tech implementation, its impact on student outcomes, and their strategies for addressing limited facilities. Additionally, FGDs were utilized to gather teachers' perceptions for policymakers, with the results reinforcing the interview data. Content analysis of students' report sheets was conducted to compare student achievements before and after the implementation of the Lo-Tech approach, specifically, comparing the previous and current semesters. Meanwhile, teachers' reflection notes offered original insights into the teaching and learning process in the classroom and occasionally provided feedback to the students. The final document was a lesson plan crafted by the teacher to guide classroom activities

Before collecting data, we applied for a research permission letter from the faculty member responsible for research affairs. Four working days later, we received the signed permission letter. We then took it to schools 1 and 2 to verify research availability and obtain participants' consent for the interviews. A week later, we returned to the schools to confirm permission and were granted approval to conduct the investigation. Finally, we requested participants' WhatsApp numbers to facilitate communication during the study. We also checked their availability for flexible interview times to ensure that information could be delivered in a relaxed manner. We interviewed all participants on different days, ensuring that they were not informed of each other's participation to avoid biased responses.

Data analysis and trustworthiness

We employed thematic analysis to examine the collected data to identify patterns, categories, and themes that emerged from the four distinct data sources. The process began with verbatim transcripts of the interview results and focus group discussions (FGD). The researchers then engaged in familiarization by repeatedly reading the entire dataset to gain a comprehensive understanding of the participants' experiences in Lo-Tech. Additionally, we conducted open coding to highlight meaningful units relevant to the three main research focus areas: implementation, impact and perception.

The initial coding categorized the data into broad categories such as strategic pedagogy, challenges, creativity, student responses, and forms of Lo-Tech adaptation. The interviews revealed personal insights into the teachers' experiences, while the FGD aimed to triangulate perspectives, thereby strengthening or enriching the interview findings. The FGD results also helped identify a consensus, even when teachers' perceptions varied.

Subsequently, content analysis, specifically report sheets, was conducted by comparing previous and current semesters or before and after Lo-Tech implementation. This comparison empirically aligns with improvements in student outcomes, reinforcing the interpretation of the interview results. Teachers' reflection notes were analyzed to capture their reflections and feedback during the teaching process. These notes were instrumental in highlighting daily changes in individual students, teaching strategy adjustments, and student responses that were not explored through interviews. It is also crucial to note student interactions, as reflections occur at the end of each day's lesson. The teacher's reflection notes are particularly accurate in assessing the impact of Lo-Tech, complementing the lesson plan used to check the consistency between planning and classroom implementation. Overall, the data sources were compared using triangulation methods, including interviews, FGD, report sheets, reflection notes, and lesson plans. Consequently, the final results possess high credibility and provide a comprehensive view of real learning in rural schools in Papua as presented in figure 1.

Figure 1. Thematic Data Analyis.

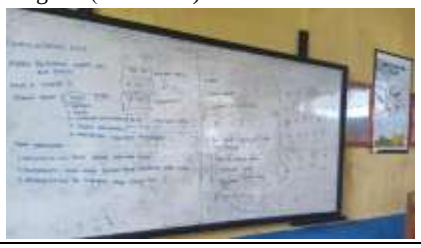
FINDINGS

1**. How do teachers implement Lo-Tech in rural indonesia primary school?**

The present study identified that educators employed four Lo-Tech pedagogical stages: (1) planning, (2) implementation, (3) monitoring, and (4) evaluation. These stages show that rural teachers use Lo-Tech adaptive strategies and focus on students' basic needs rather than digital technology as can be seen clearly in table 1.

Table 1. Low-Teach Implementation by Papuan Rural Teachers

Theme	Sub-theme	Deskripsi Temuan	Contoh Kutipan Guru
1. Planning	1.1 leveraging your own devices	Teachers use their personal laptops to create lesson plans, syllabi, and administrative documents.	"I relied on my personal laptop for school tasks unless my work was postponed. (Teacher 1)
	1.2 Googling & YouTube	Teachers searched for learning media such as animal pictures, testing, and downloading videos for watching offline in the class.	Because unstable Internet connection so that I downloaded video at my home for learning source in the classroom". (Teacher 2)
	1.3 Printing learning materials using the school's printers.	Teachers printed all the materials Ithey downloaded from the Internet using the school's devices.	"Buying a printer is too expensive for me, so I used the school's devices, even though their ink is not compatible with color printing." (Teacher 3)
	1.4 Providing concrete measurement	For the standard measurement lesson in mathematics, we used a digital scale and a long rule owned by the school.	The school did not have a meter roll, so I bought one to support students' practice." (Teacher 4) 
2. Implementation	2.1 delivering learning material using PPT and projector	Sometimes, teachers used PPT to deliver learning material to encourage students' activeness in the classroom	I have limited time to prepare the PPT because I am also finishing my master's degree." (Teacher 5)
	2.2 2 leveraging downloaded learning materials	Because of unstable and poor internet connection, we watched the downloaded video that teachers prepared from their home.	"Downloaded videos, such as science and English songs, will be watched together in the classroom offline." (Teacher 6) 
	2.3 Leveraging WAG for instructional communication.	Teachers remaining tasks deadline and checking attendance using voice note in WAG.	"If my students did not attend class, I asked their parents who had a WA number that could be called because sometimes parents also did not have an Internet package."
	2.4 leveraging concrete measurement for Math lesson.	Digital scale and meter roll that provided by teachers applyin to measure students table and their weight.	'I asked students one by one to measure their height and weight so that they could practice and understand better if they did it themselves." (Teacher 7)
	2.5 Leveraging pictures	Teachers showed downloaded	"These pictures were used to substitute students'

	as learning media.	animal pictures to help students learn about the kinds, characteristics, and behavior of animals.	books." (Teacher 1)
	2.6 Leveraging visual media for literacy and numeracy.	Teachers contacted parents to ensure the absence of students in the classroom.	" I sticked alphabets and numbers picture on the wall so that my students everyday even while their breaktime." Teacher 2) 
3. Monitoring	3.The WAG was used to check attendance	Teachers contacted parents to ensure the absence reason of students in the classroom.	"I contacted the parents to ensure that their children were not in the classroom because I did not know that they had left home but did not arrive in the classroom." (Guru K)
	3.2 Remaing tasks deadline through WAG	Teachers sent reminders and voice notes that the time left for task submission was by WAG.	"I usually reminded my students or their parents to submit heir homework befoere deadline." (Teacher 3)
4. Evaluation	4.1 Assesment-based on learning process	The most essential aspect for me as their teacher was assessing them throughout the learning process in class.	"I could directly and individually observe them when they were involved in each material that was to be taught." (Teacher 4) 
	4.2 This reflects leveraging Lo-Tech to improve the teaching and learning process.	Teachers reflected on the effectiveness of Lo-Tech based on students' outcomes in the final.	"If my students' results were good or improved, it meant that the media I used was effective, unless I replaced it for the upcoming semester. This is my self-reflection." (Teacher 5)

2. How does Lo-Technology implementation affect student outcomes?

Improving students' outcomes

This study investigates whether Lo-Tech implementation in rural schools in Papua improves students final semester outcomes (Tabel 2). This improvement can be seen in detail by comparing the use of Lo-Tech technology in the classroom. Nevertheless, the students' results were not intervention or treatment directly in the classroom by the researcher, simply referring to participants' field experiences as teachers and class supervisors.

The text addresses interviews, focus group discussions, content analysis (students' report sheets), and teachers' reflection notes. Teacher 1 noted a significant improvement in students' outcomes after incorporating Lo-Tech methods in the past semester (academic year 2024/2025). They discovered that simple media, such as pictures of animals, printed worksheets, downloaded videos from home, and roll meters as tangible tools, greatly aided students in understanding learning materials that resonated with their lived experiences. Additionally, despite its simplicity, WAG proved extremely useful for teachers in effectively monitoring attendance and assignments.

Upon comparing the previous semester's report with the current semester, where Lo-Tech was consistently implemented, educators noted improvements in several core subjects (Table 2). They highlighted that students grasp scientific concepts more rapidly when exposed to images of animals and short downloaded videos. In mathematics, the use of a meter roll and digital scale facilitated a better understanding of the measurement process, as students engaged in hands-on experimentation.

Additionally, teachers observed enhanced fluency in reading and writing among students after the classroom walls were adorned with the alphabet and numbers, allowing students to reference them as required.

Tabel 2. Students' Outcomes

Subjects	Before using Lo-Tech/ Average	After Lo-Tech/ Average	Teacher's reflection
Indonesian Language	68	76	Students find it easier to understand reading texts because there are pictures and videos.
Math	65	74	A concrete measurement tool is required.
Science	67	78	Picture's animal and offlien video encourage students' interest
Citizenship	70	75	PPT helps value the character of theoguh visual.
English	72	80	Visual media motivates students to be more creative and braver.

Affecting social-connectedness

The most essential, the current study revealed that the implementation of Lo-Tech solutions in rural Papuan schools influenced students' social connectedness and perspectives on equity. When students watched downloaded content together in the classroom, they compared their height and weight with each other while pointing at pictures of animals. For instance, one student would show a picture of a deer, while another would describe its characteristics. Through this activity, the students learned to communicate, collaborate, and build social relationships. However, such an impact is less likely to be observed in high-tech learning environments, where each student is preoccupied with their own device.

Rural educational equity

Furthermore, our study demonstrates that Lo-Tech solutions enable all students to learn without relying on personal devices for learning. In rural Papua, many students have limited access to mobile phones and the Internet. Consequently, this study confirms that all students receive the same materials, media, and learning experiences, without exception. This is referred to as justice or equity in rural education.

Teacher 1 *" In the third class, no student had a personal handphone or computer, so we used printed tasks to be done at their home."*

From the brief excerpt above, it becomes clear that delivering learning materials is not feasible for the third class because of its inappropriateness. Teacher 1 remarked, *"When we watch downloaded content together, my students sit hand-in-hand, appearing more connected. Honestly, I enjoy witnessing their camaraderie."*

3. How do teachers perceive Lo-Tech implementation in Papuan rural schools?

The novelty of the current study is that teachers perceived the impact of Lo-Tech implementation in Papuan rural schools aligning with socio-pedagogical perspectives on rural educational resilience, including (1) the main teachers' role as agency, (2) inclusivity, and (3) appropriateness**.**

Teacher agency

Teacher agency in the context of limited resources is exemplified by the innovative practices of educators in rural Papuan schools. Teachers in these settings perceive the scarcity of technological pedagogy as an impetus to act as agents bridging the gap between limitations and resilience, thereby fostering survival pedagogy. Consequently, they develop learning materials and promote creativity in their students. These educators assume the role of resilience pedagogy agents in rural schools, taking the initiative to procure necessary teaching materials. For instance, one teacher stated, "The school did not have a meter roll, so I bought one" (Guru D). This purchase was made to ensure measurement validity because the cost was reasonable. By taking such actions, teachers demonstrate agency in the face of limited pedagogical resources rather than passively waiting for school provisions. However, for more costly items, such as printers and ink, they often rely on school facilitation due to the prohibitive expense for rural teachers to purchase these items.

Inclusiveness

The current study shows that Lo-Tech isn't just a technical choice but also an inclusive strategy that promotes learning equity for all students, regardless of their socioeconomic background or access to technology. In situations where internet connectivity is unstable, electricity is limited, and digital devices are not equally available, using simple media such as printed or self-drawn pictures ensures that no student is left behind due to inadequate devices. In this context, teachers see this as a form of justice in learning, as one teacher expressed: "These pictures were used to substitute students' books." (Teacher 1) This statement indicates that printed pictures act as a bridge for students who lack books.

Moreover, Lo-Tech supports students with low literacy. Visual media, like pictures of animals, numbers, letters, and short videos, help students who struggle with reading by allowing them to learn through visual experiences and hands-on practice instead of just text. "I stuck alphabet and numbers pictures on the wall so that my students see them every day." (Teacher 2) This method exemplifies true inclusion. Lo-Tech caters to students with different learning styles: kinesthetic students benefit from concrete measuring tools, visual students from pictures and PowerPoint presentations, and auditory students from offline videos and songs. Lo-Tech makes learning more accessible to various learning preferences, not just academically strong students.

Additionally, Lo-Tech strengthens the school-parent relationship. WAGs enable parents who cannot visit the school to stay engaged. "I contacted the parents to ensure their children were not in the classroom." (Teacher 2) Inclusivity here includes both students and communication with their parents or guardians.

Appropriate Technology

Levareging Lo-Tech as explained in the table 1 emphasizes that technology used appropriate with the Papuan rural schools, its prices are cheap, easy for maintainnace, can be operated school's teachers, and independence-used. Teachers chose these because they knew that unsupported internaet connection

"Due to an unstable Internet connection, I downloaded the video at home." (Teacher 2).

The choice of these medium stems from a genuine need and is influenced by idealism. Additionally, Lo-Tech solutions can be operated by teachers without specific training, as they are already familiar with them, making them a sustainable choice. The essence of appropriate technology is to enhance local capacity, rather than replace it. This technology encourages teachers to become creative and adaptive learning designers. Ultimately, it is relevant to the local context of daily life, making it widely acceptable to the local population. The results indicate that students become more actively engaged because PPT slides create a more dynamic classroom atmosphere, are easy to download, and downloaded videos can be watched repeatedly.

"Downloaded videos, such as science and English songs, will be watched together in the classroom offline." (Teacher 5).

DISCUSSION

To address the research questions, this section delves into teachers' pedagogical strategies for implementing Lo-Tech solutions in seven teachers of two rural schools in Papua. It outlines four stages of Lo-Tech pedagogy: (1) planning, (2) implementation, (3) monitoring, and (4) evaluation. The implementation of low technology influences three dimensions of student outcomes: final semester reports, students' social connectedness, and perspectives on equity. Furthermore, teachers in this study view Lo-Tech implementation in Papuan rural schools through the lens of three crucial aspects of rural education, namely resilience, which includes (1) the primary role of teachers as agents, (2) inclusivity, and (3) appropriateness of the technology used.

Our findings suggest that low technology serves as an adaptive pedagogy in real-world conditions. Girard et al. (2025) highlight that Lo-Tech is not merely about technology but also involves ingenuity and the ability of individuals to devise solutions that are well suited to their specific context and environment. To our knowledge, the teachers in the current study purchased meter rolls to measure the requirements of math lessons accurately. Similarly, our results align with Hu and Ng (2025), Trucano (2016), who asserted that Lo-Tech is not a challenge; rather, it can enhance learning access and boost student engagement by utilizing contextual media without requiring advanced skills. In the current study, the teacher substituted animals with handwritten or self-drawn illustrations to teach students about animals found in their environment and their behaviors. If the teacher lacked time to prepare these materials, she would download, print, and bring them into the classroom. Notably, the teacher encouraged students to draw animals, which is a pedagogically appropriate approach in this context.

Theoretically, our findings not only affirm the principles of Universal Design for Learning (UDL), demonstrating that learning access can be improved through a few straightforward representations that do not demand high-level access but enlarge as a strategy for resilience pedagogy. This approach acknowledges that Lo-Tech solutions are not merely technical but also serve as a pedagogical strategy that fosters effective learning, is contextually relevant, and accessible to all students (Butarbutar, Alimuddin & Leba, 2025; Sala-Bars et al., (2025).

Our findings strongly refute previous studies that highlight the drawbacks of using Lo-Tech in educational settings, especially when it serves as a sole learning medium. Dorn et al. (2020) argued that Lo-Tech alone is insufficient for developing digital literacy and 21st-century skills. Trucano and Trucano (2016) demonstrated that simple media limit pedagogical variety and content quality. Additionally, its effectiveness relies on teachers' creativity (Azano & Stewart, 2022), making it less effective in classrooms with low teacher capacity. In contrast, we found that the teachers in our study became more creative and enjoyed creating their media. In the STEM context, Lo-Tech is ineffective for providing simulations and visualizations (Nacu et al., 2018). While they acknowledged that low technology is effective in certain contexts, they also noted its disadvantages. In alignment with this, our findings challenge Nacu et al. (2018) and demonstrate that Lo-Tech can serve as a genuine simulation tool for students.

Furthermore, the introduction of Lo-Tech methods in two rural schools in Papua positively impacted students' final semester results. Although the researchers did not intervene directly, the evidence and students' report sheets clearly demonstrated significant improvement in their outcomes. This finding aligns with Sidekerskienė & Damaševičius (2025), who discovered that simple visual media enhances student engagement and understanding in STEM subjects. They emphasized that the effectiveness of visual media relies not on advanced technology but on its contextual use and ability to simplify abstract concepts. In the current study, teachers used hand-drawn or printed animal pictures as Lo-Tech tools to help students grasp mathematical concepts. This suggests that both current and previous studies concur that simple yet contextual visual media can be considered a strategic pedagogical approach, especially in areas with limited infrastructure.

Mustafa et al. (2024) found that relying solely on Lo-Tech solutions is insufficient for improving long-term learning quality, as students are behind in digital skills. Additionally, Ahiaku et al. 2025, Butarbutar & González Vallejo (2025) stressed that the lack of high-tech resources in rural schools hampers innovative teaching and limits teachers' ability to explain concepts effectively. However, the current study clearly shows that quality teaching and learning can be achieved through visually engaging, Lo-Tech methods. Our findings are supported by the concept of situated learning (Lave & Wenger, 1991), which suggests that the learning process becomes meaningful when media and activities match students' social culture. In the context of two rural schools in Papua, digital skills and innovative teaching, as discussed in the studies mentioned above, are not the main goals; instead, the success of teaching depends on local contexts, needs, and infrastructure.

To the end, our findings present that teacher in rural schools of Papua perceived that Lo-Tech by three main rural aspects: main teacher role agency, inclusiveness, socio-pedagogy context.This perspective aligns with Azano et al. (2020), Butarbutar, Pure & Rizal (2025). Komba & Nkumbi (2008), who asserted that teacher agency is the main foundation of educational resiliency in rural settings, and Hu and Ng (2026), who demonstrated that Lo-Tech enhanced students' accessibility and engagement. Additionally, the current study corresponds with Darling-Hammond, et al. (2017) Girard et al. (2025), who recognized that the effectiveness of technology is characterized by its appropriateness to the local social context and materials in which it is used. Our findings underscore that while the effectiveness of Lo-Tech in the two Papuan rural schools is not guaranteed to be successful in other rural contexts, it can serve as a conceptual framework. We advocate for the incorporation of diverse technologies to ensure the sustainability of resilience, inclusiveness, and quality of education.

CONCLUSION AND IMPLICATIONS

The current study highlights the crucial role of hLo-Tech in sustaining the resilience of the learning process in rural Papuan schools. Despite challenges such as limited infrastructure, frequent power outages, unstable or nonexistent Internet connections, and the low digital skills of teachers and students, Lo-Tech emerges as the most viable option. Tools such as WAG, offline materials, personal laptops, and simple PowerPoint presentations assist teachers in their instruction, even in the absence of student textbooks and support for prior learning at home. Our findings suggest that Lo-Tech is not merely a tool but a pedagogical survival strategy that ensures the continuity of the learning process.

Furthermore, this study demonstrates that Lo-Tech solutions can support inclusive learning. Short, clear, and accessible visual media can help students with low literacy levels. Additionally, teachers require opportunities to share their practices, although this also introduces an administrative burden that needs reconsideration as it encroaches on teaching time.

However, this study acknowledges certain limitations, such as the small number of teacher participants, which did not fully capture the experiences of teachers and parents. In-depth class interventions have not been conducted, leaving some practical aspects unexamined. Consequently, these findings should be viewed as context-specific and not generalizable to all rural areas of anonym country.

Based on these findings, several recommendations are proposed for the local and national Indonesian governments to enhance the future of education, particularly in rural areas. (1) The government should remove educators' administrative duties, allowing them to concentrate on advancing pedagogical quality. (2) Both low- and high-technology should be integrated into teaching and learning, especially in rural areas, as government attention and tangible action are essential. (3) Continuous educator training on a weekly, monthly, and semester basis is necessary to ensure that teachers remain adaptable to the evolving landscape of knowledge and technology. While teachers are not expected to know everything, the primary goal of training is to demonstrate that technology is dynamic and not static. This training is necessary to fulfill the 21st century skills of teachers and students. (4) Electricity should be provided at a high voltage to ensure 24/7 availability. (5) Parental involvement and community engagement are vital, as rural schools in Papua cannot thrive without the support of local communities, village leaders, and religious leaders working together to advance education.

We recommend that future research involve longitudinal class observations, interventions, and participatory actions. The development of a practical and conceptual Lo-Tech framework tailored to the Indonesian context is urgently required. Overall, this study underscores that Lo-Tech is not merely a collection of simple tools but a bridge that enables teachers to overcome limitations and deliver meaningful learning, serving as a survival pedagogy solution.

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Conflict of interest

The authors declare no conflicts of interest.

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