Journal of Sustainability (2026) 2:1, 1-22
https://doi.org/10.55845/jos-2026-21186

RESEARCH ARTICLE

Building the Capacities for Sustainable Development Goal 4 in an Elementary Last-Mile School in Iloilo Province, Philippines: A Sustainability Science Perspective

Michael G. Garlan[1*], Renelda P. Nacianceno[1], Bernie F. Piad[1], Jan Rex P. Osano[1]

Received: 10 May 2026 / Accepted: 1 June 2026 / Published: 5 June 2026
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Abstract

Achieving Sustainable Development Goal 4 (SDG 4) remains a challenge in geographically isolated and disadvantaged schools. This study examined the socio-ecological conditions influencing SDG 4 attainment in a Last Mile School in Iloilo Province, Philippines. A sustainability-oriented, descriptive qualitative case study design, supported by official school inventory documents and literacy assessment records, was employed to analyze learning outcomes, school resources, instructional contexts, and institutional conditions. Findings revealed severe learning deficits, with no Grade 6 learners attaining independent reading proficiency and no learners in Grades 4–6 meeting grade-level numeracy standards. These outcomes were associated with inadequate infrastructure, limited learning resources, multigrade teaching demands, and heavy teacher workloads. Systems analysis showed that these challenges are interconnected and reinforced by social and environmental factors. Using the sustainability capacities framework, the study highlights the need for integrated interventions that strengthen resource provision, teacher support, governance, and adaptive learning systems. The findings underscore that achieving SDG 4 in Last Mile Schools requires systems-oriented reforms that address the broader socio-ecological conditions shaping educational inequities.

Keywords Last Mile School · Reading Literacy · Numeracy · Socio-ecological System · Multigrade Classrooms · Sustainable Development Goal 4 · Systems Thinking

1. Introduction

Educational inequality remains one of the most persistent barriers to achieving United Nations Sustainable Development Goal 4 (SDG 4), particularly in geographically isolated and socioeconomically marginalized communities in developing countries. In the Philippines, educational access and quality continue to be constrained by geographic isolation, chronic infrastructural deficits, poverty, limited government reach, and the historical marginalization of Indigenous Peoples (IP) communities (UNICEF Philippines, 2023; World Bank, 2022). These structural inequities are especially visible in remote rural schools where learners experience limited access to safe learning spaces, qualified teachers, electricity, digital connectivity, sanitation facilities, and culturally responsive instruction. Such conditions significantly affect educational participation, literacy and numeracy achievement, learner retention, and long-term social mobility, thereby threatening the realization of inclusive and equitable quality education under SDG 4 (UNESCO, 2024).

In response to these persistent disparities, the Department of Education (DepEd) institutionalized the Last Mile Schools (LMS) Program in 2019 to prioritize schools experiencing severe educational deprivation. DepEd (2019) defines LMS as schools characterized by fewer than four classrooms, makeshift or nonstandard school structures, absence of or limited electricity, lack of repairs or infrastructure development within four years,

* Corresponding author: michael.garlan@isatu.edu.ph
[1] College of Education, Iloilo Science and Technology University, La Paz, Iloilo City. Philippines

difficult geographic terrain or travel distance exceeding one hour from town centers, multigrade classes, fewer than five teachers, fewer than 100 learners, and populations composed predominantly of IP learners. Recent national reports indicate that more than 7,000 schools across the country now fall under the LMS classification, collectively serving over 1.6 million learners, many of whom are located in geographically isolated and conflict-affected areas, particularly in the Bangsamoro Autonomous Region in Muslim Mindanao (Philippine Information Agency, 2025; Rappler, 2025). Despite strong policy articulation and increasing government investment, substantial implementation gaps remain. Reports from the Commission on Audit (COA) revealed that at least 76 LMS infrastructure projects remained unfinished in 2023, with delays extending up to 555 days due to procurement inefficiencies, weak project monitoring, and contractor noncompliance (COA, 2024; PhilStar, 2024). These delays expose deeper systemic problems in educational governance and infrastructure delivery, particularly in remote communities where schools remain vulnerable to resource scarcity and institutional neglect. In Western Visayas, including Iloilo Province, similar patterns persist.

Regional assessments have documented schools lacking electricity, functional toilets, adequate classrooms, potable water, and disaster-resilient infrastructure (DOH & DepEd Region VI, 2023; PIA VI, 2025). Provincial interventions such as the "*Bulig Eskwela sang Probinsya*" initiative, which distributed tent-type temporary classrooms to geographically isolated schools, demonstrate local government responsiveness but simultaneously reveal the severity and persistence of infrastructure inadequacies (Rappler, 2025). Beyond infrastructure deficits, emerging studies suggest that educational sustainability in marginalized contexts cannot be understood solely through physical resource provision. Sustainability science literature emphasize that educational outcomes are shaped by dynamic interactions among infrastructure, teacher workload, governance systems, environmental conditions, community participation, cultural relevance, and learner well-being (Clark & Harley, 2020; Redman & Miller, 2023). In LMS contexts, multigrade teaching, excessive administrative responsibilities, limited instructional resources, and weak institutional support interact recursively to reinforce poor learning outcomes and educational vulnerability. Moreover, for schools serving IP communities, the absence of culturally responsive pedagogies, linguistically appropriate materials, and meaningful community participation further intensifies educational inequities (Bacaltos & Salvatierra, 2024; UNESCO, 2024). However, despite increasing national attention to LMS, there remains a significant scholarly gap in localized, systems-oriented investigations that examine how multiple socio-ecological subsystems interact to influence SDG 4 outcomes in a particular elementary school classified as LMS. Existing LMS studies largely focus on infrastructure provision, policy implementation, or descriptive profiling, with limited application of systems thinking, sustainability science, or socio-ecological frameworks capable of explaining the reinforcing feedback mechanisms that sustain educational disadvantage. Furthermore, empirical studies situated in Western Visayas, particularly in remote municipalities, remain scarce despite the region's vulnerability to educational inequality and infrastructural deprivation. The absence of contextualized evidence constrains the development of sustainable, place-responsive, and culturally grounded educational interventions.

Recent Philippine-based studies highlight persistent challenges in achieving SDG 4, particularly in geographically isolated and multigrade school contexts. Research consistently reports that educational inequities in Last Mile Schools (LMS) stem from interconnected issues involving weak infrastructure, limited instructional resources, teacher overload, digital exclusion, and poor literacy and numeracy outcomes. For instance, Sustainability Science-oriented analyses of LMS contexts revealed that multigrade instructional pressures, inadequate facilities, and socio-economic vulnerabilities reinforce low learner proficiency and constrain educational resilience (Garlan, 2025). Similarly, studies on multigrade education in the Philippines identified insufficient professional development, lack of instructional materials, and classroom management difficulties as major barriers affecting teaching effectiveness and learner achievement (Hermosa & Sanchez, 2025). Recent evidence also emphasized the worsening literacy crisis in the country, with inequities in access, parental support, and community participation undermining inclusive education goals under SDG 4 (Gatcho et al., 2024). In remote schools, the digital divide further limits reading development and learning continuity, particularly among emergent readers lacking internet access and learning technologies (Oliver, 2022). Emerging intervention studies nevertheless suggest that context-responsive and technology-supported learning systems can improve educational outcomes in remote Philippine schools when institutional support and localized implementation mechanisms are strengthened (Glewwe et al., 2025). These studies collectively demonstrate that educational sustainability in Philippine LMS contexts requires integrated, systems-oriented, and equity-driven interventions that address both instructional and socio-ecological dimensions of learning.

This study addresses this gap by applying sustainability science perspectives to examine the SDG 4 performance of one Last Mile School in Iloilo Province. Instead of presenting a generalized analysis of rural

Philippine education, the study offers a localized case-based investigation of how interconnected structural, instructional, institutional, and socio-economic conditions shape educational sustainability in one geographically isolated elementary school. The study is guided primarily by systems thinking and socio-ecological systems (SES) perspectives of sustainability science, which view educational outcomes as products of interacting institutional, instructional, environmental, and community-level conditions. Systems thinking and SES serve as the analytical lens for examining reinforcing constraints and interactions affecting educational performance. Meanwhile, the six sustainability capacities framework of Clark and Harley (2020) is used as an interpretive framework for identifying sustainability-oriented educational implications and pathways for strengthening SDG 4 implementation.

Specifically, the study aimed to:

1. describe the current conditions of the identified Last Mile School in terms of SDG 4 means of implementation and learning outcomes;
2. analyse how interacting socio-ecological conditions influence SDG 4 performance using systems thinking; and
3. identify sustainability-oriented educational implications using the six sustainability capacities framework of Clark and Harley (2020).

2. Methodological Perspective

2.1. Research Design

This study employed a sustainability-oriented, descriptive qualitative case study design to examine the SDG 4 conditions of one Last Mile School in Iloilo Province, Philippines. A sustainability-oriented qualitative case study approach was appropriate because it provides tools for researchers to study complex phenomena within their contexts (Baxter & Jack, 2008). The study was anchored primarily on systems thinking and socio-ecological systems perspectives as analytical approaches. Systems thinking was used as the principal analytical lens to examine how infrastructure conditions, teacher workload, learner outcomes, governance structures, and community realities interact as interconnected educational subsystems rather than isolated variables. Systems thinking is a way of understanding the web of interrelations that create complex problems (Voulvoulis et al, 2022). The socio-ecological systems (SES) provide a framework for understanding the complex dynamics occurring between environmental and societal changes. Social-ecological systems are understood as complex adaptive systems where social and ecological components are deeply interconnected (Biggs et al., 2021) and this perspective guided the interpretation of how institutional, instructional, and environmental conditions collectively shape educational sustainability. The six sustainability capacities framework of Clark and Harley (2020) was subsequently used as an interpretive framework for discussing sustainability-oriented educational implications emerging from the case findings.

2.2. Study Context

The study focused on the case of a one public elementary school officially classified by the Department of Education as a Last Mile School located in Iloilo Province, Philippines. To preserve partial institutional confidentiality, the school's name and specific identifying information were withheld except a photograph of a makeshift infrastructure is included. The school is characterized by multigrade instruction, geographically difficult access, limited educational facilities, and a relatively small learner population. Most learners come from low-income households dependent on seasonal agricultural labor.

2.3. Data Sources

The study primarily utilized documentary sources supplemented by limited contextual focus group discussions conducted with teachers and the officer-in-charge school head.

Table 1. Data sources and limitations

Source Type	Year	Content Coverage	Relevance	Limitation
School Profile	2024-2025	Enrolment, facility inventory, staffing	School context and SDG 4.a conditions	Institutional reporting limitations
Phil-IRI Report	2025	Reading proficiency levels	SDG 4.1.1.b literacy outcomes	Cross-sectional assessment only
Numeracy Assessment Report	2025	Numeracy proficiency	Mathematics learning outcomes	Cohort-based data
Infrastructure Assessment Reports	2024-2025	Classrooms, WASH, facilities	Educational environment analysis	Descriptive institutional reports
Instructional Monitoring Documents	2024-2025	Multigrade teaching conditions	Teacher workload and pedagogy	Internal institutional documents
School Program Implementation Reports	2024-2025	Governance and activities	Institutional support conditions	Limited longitudinal evidence

All documentary sources examined in this study were official records generated and maintained either by the school administration or by the Department of Education (DepEd) through authorized reporting and assessment systems. The authenticity, completeness, and credibility of the documents were verified through the presence of official signatures, dates, institutional identifiers, and cross-validation with related records. To supplement and contextualize the documentary evidence, a focus group discussion (FGD) was conducted once with five teachers and the officer-in-charge school head who possessed direct knowledge of school operations and administrative practices. Participation was voluntary, and informed consent was obtained prior to the discussion. The FGD explored topics related to workload distribution, administrative responsibilities, implementation challenges, and operational realities reflected in the documentary records. The discussion was documented through field notes and was not treated as a standalone dataset for analysis. Instead, insights generated from the FGD were used to contextualize, corroborate, and enrich themes emerging from the documentary analysis. This triangulation process enhanced the credibility and interpretive depth of the findings while maintaining documentary sources as the primary basis of analysis. Documents were purposively selected based on:

1. relevance to SDG 4 implementation;
2. availability and completeness of records;
3. institutional credibility;
4. direct relevance to infrastructure, instructional, governance, and learner outcome conditions.

2.4. Data Analysis

Data were analyzed through descriptive coding and thematic analysis following Braun and Clarke (2021). Documentary evidence was initially coded according to major SDG 4 dimensions including infrastructure, teacher capacity, instructional conditions, learner outcomes, and governance support. Recurring themes and patterns were then synthesized using systems thinking analysis. Systems mapping techniques were used to identify conceptual relationships among variables such as infrastructure deficits, teacher workload, multigrade instruction, learner proficiency, and institutional support. The causal loop diagrams presented in the study are conceptual synthesis tools derived from thematic interpretation rather than empirically validated system dynamics.

2.5. Ethical Consideration

The researchers ensured that the study was conducted in accordance with established ethical principles governing educational research. Measures were undertaken to protect the privacy, dignity, and confidentiality of the participating school and individuals throughout the research process. To safeguard confidentiality, identifiable school information and related records were encoded and presented using non-identifiable labels and coded representations whenever applicable. All collected data were securely stored in password-protected

digital repositories and organized files accessible only to the authorized members of the research team. However, as part of the contextual documentation of the research setting, a photograph of the school canteen was included in the study. Complete institutional anonymity could not be fully guaranteed. Nevertheless, the researchers ensured that the image did not disclose sensitive personal information or identifiable student data and was used strictly for academic and illustrative purposes in accordance with ethical and institutional research guidelines. The conduct of the study adhered to the principles of voluntary participation, informed consent, confidentiality, and responsible data management. Participants were adequately informed regarding the nature, purpose, and procedures of the study prior to their involvement, and their participation was treated with utmost respect and confidentiality. The researchers also ensured that the gathered data would be used solely for academic and research purposes. Prior to the conduct of data gathering, the research protocol underwent ethical evaluation and was formally approved by the Research Services Division, certifying that the study complied with institutional ethical standards and research guidelines.

3. Results & Discussion

3.1. Current Conditions of the Identified Last Mile School in Terms of the Means of Implementation to Achieve SDG 4

The Last Mile School (LMS) identified by the Department of Education VI is a public basic education institution located in one of the remote barangays in the third district of Iloilo province in the Western Visayas Region of the Philippines. The school is officially classified by the Department of Education (DepEd) as a Last Mile School (LMS) based on multiple indicators of geographic isolation and resource deprivation. According to DepEd's LMS criteria, these schools typically have fewer than four classrooms, makeshift or nonstandard school buildings, lack of electricity, absence of repairs or construction within the last four years, travel time of more than one hour from the town center or access through difficult terrain, multigrade classes, fewer than five teachers, fewer than 100 enrolled learners, and more than 75% Indigenous Peoples (IP) learners (DepEd, 2019). The identified LMS exhibits several of these conditions such as the lack of computer for pedagogical purposes, PWD-friendly infrastructures, library, and laboratory while canteen is makeshift, making it representative of the systemic challenges experienced by LMS communities in Western Visayas (Figure 1). Situated far from municipality's capital, the school is accessible only through rough, narrow roads that become difficult to traverse during the rainy season.

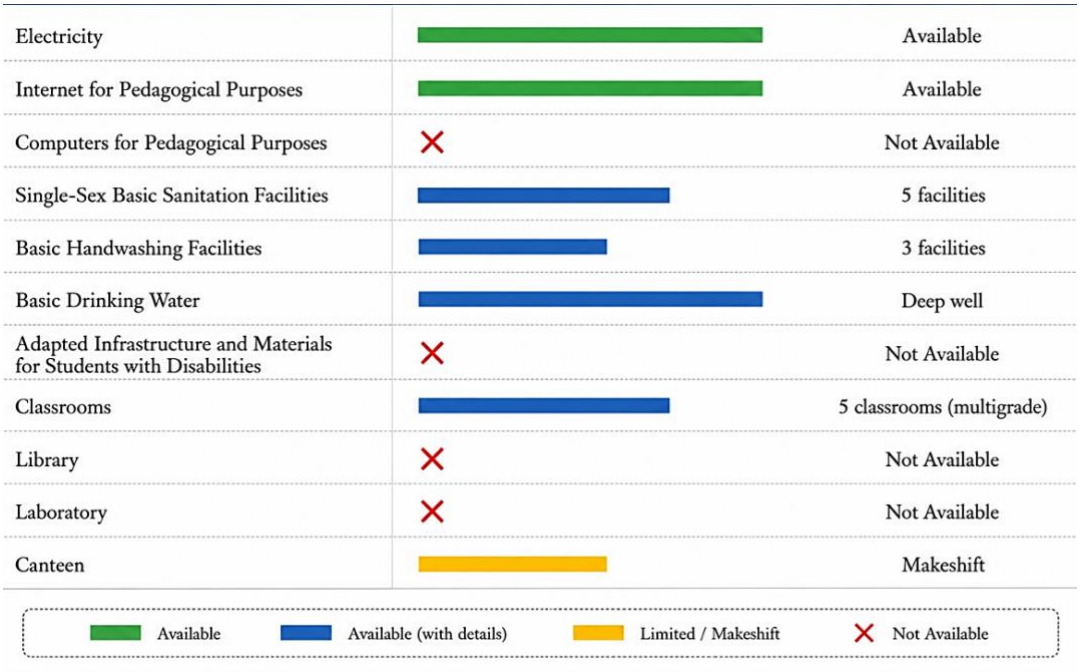

Figure 1. Identified LMS facilities based on school inventory (SDG 4.a).

These geographic constraints contribute to the school's limited access to government services and logistical support. The school operates with a small teaching workforce managing multigrade classes due to its low but dispersed student population. Facilities are either makeshift or constructed from nonstandard materials, reflecting long-standing infrastructure gaps. The school's lack of enough classrooms, limited access to water, and minimal instructional resources further constrain teaching and learning processes. Additionally, a significant proportion of the learners come from marginalized households whose livelihoods are tied to subsistence agriculture and seasonal labor, shaping the socio-economic context in which the school functions.

3.1.1. SDG Target 4.a Effective Learning Environments (Build and Upgrade Education Facilities that Child, Disability, and Gender Sensitive and Provide Safe, Non-Violent, Inclusive, and Effective Learning Environments for All)

SDG 4.a underscores the importance of safe, inclusive, and effective learning environments, recognizing that adequate physical infrastructure and essential services are prerequisites for achieving quality education. This target is particularly relevant for Last Mile Schools such as the identified elementary school, where geographical isolation and socio-economic constraints historically limit resource availability and learning opportunities. The school operates with only five multigrade classrooms and is exacerbated by the absence of computers for pedagogical purposes, which restricts opportunities for digital literacy and ICT-integrated learning, skills that are increasingly essential in the 21st century and highlighted in SDG 4 competencies. While internet connectivity is available to teachers, the lack of learner-level ICT access limits the potential for interactive, technology-enhanced instruction and reduces opportunities to integrate learning management systems, online assessments, or multimedia resources. This digital divide is pronounced in LMS and reinforces systemic inequities in access to contemporary learning tools. In terms of water, sanitation, and hygiene (WASH) facilities, the LMS maintains five single-sex sanitation facilities and three functional handwashing stations. These contribute to a safer, more hygienic environment conducive to student wellbeing. However, the school's reliance on a deep well for drinking water raises concerns about water potability, safety, and sustainability particularly during dry seasons or extreme weather, where supply may be disrupted. Reliable access to clean drinking water is not only a basic service but also directly affects attendance, learner comfort, and health outcomes. Despite improved classroom structures, the school still lacks several key facility types central to an enabling learning environment: no dedicated library, no laboratory, and only a makeshift canteen is available. The absence of a library limits opportunities for reading enrichment and research activities that support literacy development and independent learning. The lack of a science laboratory further constrains experiential learning and inquiry-based teaching, critical components of the K–12 curriculum and essential for fostering scientific literacy. Furthermore, the identified LMS has no adapted infrastructure or learning materials for students with disabilities, which runs counter to the SDG 4 commitment to inclusivity. Without assistive devices, accessible pathways, or specialized learning resources, learners with disabilities, if present, would face significant barriers to participation and equitable learning. While the LMS has made progress in expanding classroom infrastructure and securing basic utilities, its partial alignment with SDG 4.a reveals a learning environment that remains fragile, under resourced, and highly dependent on local socio-ecological conditions. The gaps in ICT resources, specialized learning facilities, inclusive infrastructure, and reliable water services illustrate how structural deprivation continues to shape educational experiences in Last Mile contexts. These conditions, when viewed through a socio-ecological systems perspective, interact with factors such as community capacity, environmental constraints, and teacher workload ultimately influencing the school's SDG 4 performance and student learning outcomes.



Figure 2. Makeshift canteen of the identified LMS. Photo is posted with consent.

3.1.2. SDG Target 4.c Teachers and Educators *(By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States)*

Table 2 presents the distribution of teaching personnel in the identified Last Mile School (LMS) according to sex, professional eligibility under Republic Act 7836, and graduate educational attainment. All teachers are licensed professional teachers (LET passers), demonstrating compliance with national qualification standards for basic education teachers. However, none of the teachers currently holds a master's or doctorate degree, highlighting the need for greater access to continuous professional development, multigrade instructional support, mentoring, and institutional capacity-building mechanisms aligned with SDG 4.c targets on teacher support and educational quality.

Table 2. Teacher distribution by sex, eligibility and graduate school status at LMS

Faculty	Number	Percentage	Eligibility (RA 7836)	Master's Degree	Percentage	Doctorate Degree	Percentage
Male	3	37.50%	LET	0	0.00%	0	0.00%
Female	5	62.50%	LET	0	0.00%	0	0.00%
Total	8	100.00%	All LET Passers	0	0.00%	0	0.00%

Teachers constitute a critical component of the education system and play a central role in achieving SDG 4: Quality Education. SDG Target 4.c emphasizes the need to increase the supply of qualified teachers while also strengthening teacher support, training opportunities, and equitable deployment, particularly in geographically isolated and disadvantaged areas where educational inequities remain most pronounced. In the Philippines, national policies such as Republic Act 7836 and DepEd hiring standards require teachers to possess appropriate professional qualifications and pass the Licensure Examination for Teachers (LET), thereby establishing a baseline level of professional competence for delivering the K–12 curriculum. In the identified Last Mile School (LMS), all eight teachers hold Bachelor of Elementary Education degrees and are LET passers, demonstrating compliance with national qualification requirements despite the challenges

associated with recruitment and retention in remote multigrade settings. However, the findings suggest that the more immediate constraints affecting teaching effectiveness in the LMS relate less to the absence of graduate degrees and more to limited access to sustained professional development, multigrade instructional support, workload protection, instructional coaching, and institutional assistance systems. Teachers in the LMS simultaneously manage multigrade instruction, administrative tasks, community engagement activities, school maintenance responsibilities, and coordination with local government units, all of which reduce instructional focus and limit opportunities for pedagogical improvement (Figure 3). In this context, teaching quality depends not only on formal credentials but also on the extent to which teachers receive continuous professional learning opportunities, context-responsive training, mentoring support, and adequate institutional conditions that enable effective classroom practice. Remote school contexts often restrict access to professional learning communities, specialized multigrade teaching programs, coaching mechanisms, and in-service training due to geographic isolation, financial constraints, and heavy workloads.

These conditions constrain teachers' capacity to implement differentiated instruction, address diverse learner needs, strengthen foundational literacy and numeracy, and adapt instruction to resource-limited environments. From a systems thinking and sustainability science perspective, teacher effectiveness emerges from the interaction between professional capability and the broader institutional environment that supports or constrains instructional practice. Improving SDG 4 attainment in LMS contexts requires systemic investments not only in teacher recruitment and credential compliance but also in sustained professional development, workload management, multigrade teaching assistance, mentoring systems, and institutional support structures that strengthen long-term instructional resilience and educational quality.

- **Non-Teaching Roles of Teachers at LMS**

Under the Magna Carta for Public School Teachers, each public-school teacher has a regular full-time teaching load and is mandated to devote at most six hours of actual classroom instruction a day. But teachers interviewed complain about being overburdened by administrative or student support roles, including report writing on seminars and trainings they are tasked to attend as well as designations in line with student guidance, budget, disaster response, and health (David et al. 2019). Teachers in the LMS carry a wide range of non-teaching responsibilities that significantly shape their capacity to deliver quality instruction, a key requirement of SDG 4 (Figure 3). Beyond classroom teaching, they handle extensive administrative work such as preparing school forms (SF 1, 2, 4, 5), updating learner information in Learner Information System (LIS) and Enhanced Basic Education Information System (EBEIS), and completing accomplishment reports. They also take charge of school operations and maintenance, including documentation for audits, property inventory, school beautification, and even minor classroom repairs tasks typically assigned to support staff in better resourced schools. In addition, teachers organize and manage school programs and events like Nutrition Month and serve on multiple committees throughout the year. Their roles extend to stakeholder engagement, participating in community outreach activities and clean-up drives, thereby strengthening school and community ties but adding to their workload. As focal persons for programs such as GAD and DRRM, teachers coordinate with LGUs, communicate with parents, and assist in division or regional activities. Collectively, these non-teaching duties reflect the systemic realities of a Last Mile School, where limited personnel and resource constraints compel teachers to assume multiple roles.

This heavy workload reduces the time available for lesson preparation, individualized support, and pedagogical improvement, ultimately affecting the school's overall SDG 4 performance and highlighting the need for stronger institutional support to protect teachers' instructional focus.

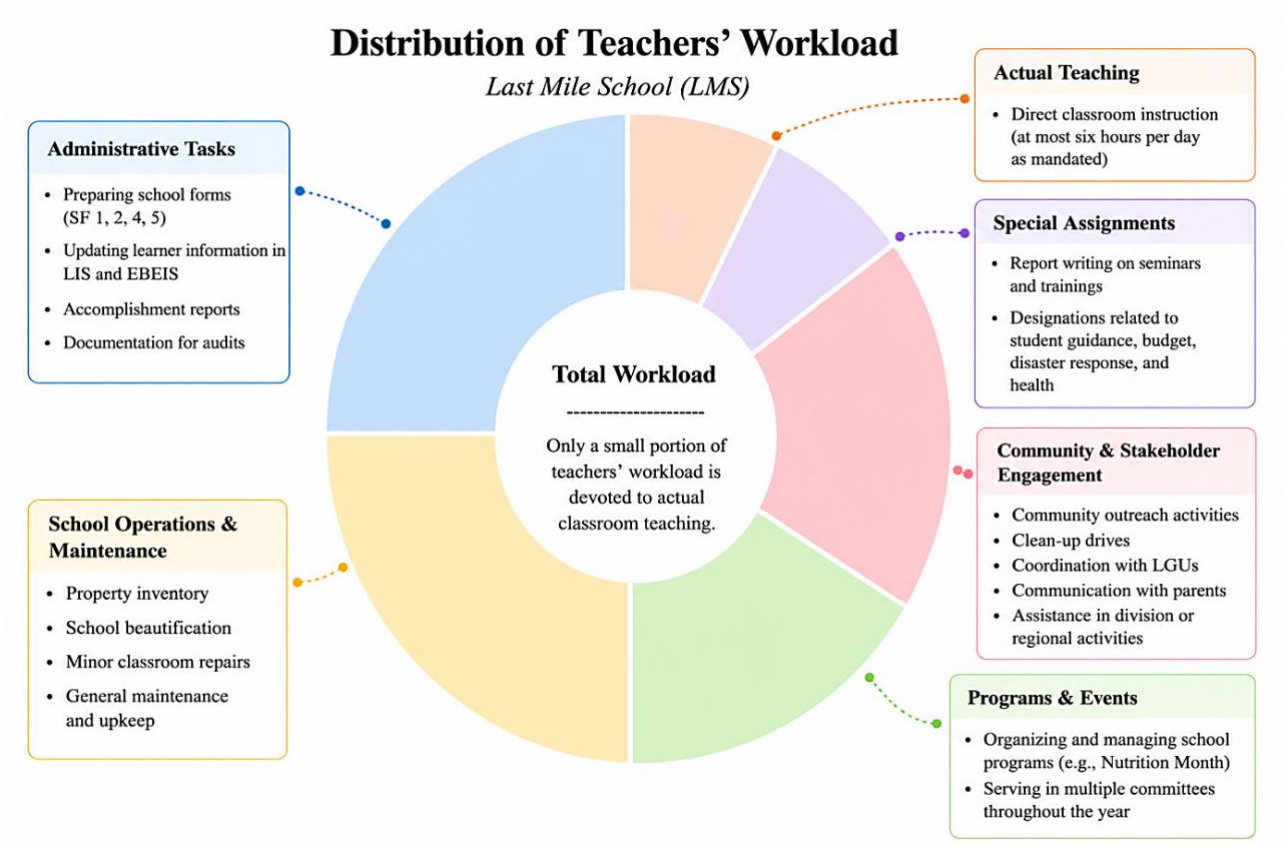

Figure 3. Non-teaching and teaching roles of teachers in the identified LMS

- **Teaching Roles**

Actual teaching in the LMS follows a multigrade instructional model, requiring teachers to manage multiple grade levels simultaneously within a single classroom. The teaching flow typically begins with a whole-class routine such as morning greetings, shared discussions, or foundational skill review to establish structure and a sense of community among learners of different ages. After this shared opening, instruction shifts into small-group or independent learning activities that are carefully differentiated according to grade level competencies. While one group engages in seatwork, practice tasks, or self-directed learning, the teacher delivers focused, grade-specific instruction to another group, ensuring that each set of learners receives appropriate guidance aligned with their curriculum needs. The teacher then rotates among groups, balancing direct instruction, monitoring, and feedback across multiple grade levels. This continuous cycle of grouping, rotating, and managing independent tasks reflects the complex demands of multigrade teaching, where effective learning relies on strategic classroom organization, strong instructional planning, and the teacher's ability to simultaneously address diverse learner needs within a resource-constrained environment.

3.1.3. SDG Target 4.1 (Universal primary and secondary education): By 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes)

The enrolment profile of the LMS for School Year 2025–2026 provides an initial picture of the school's progress toward SDG Target 4.1, which aims to ensure that all children complete free, equitable, and quality primary education. The data show relatively stable enrolment across the upper primary grades, with 15 learners in Grade 4, 14 in Grade 5, and 20 in Grade 6, indicating that learners are generally staying in school through the later years of elementary education. This is significant for a Last Mile School, where geographic isolation, household responsibilities, and socio-economic constraints often lead to dropout or irregular attendance. The near-balanced gender distribution particularly the equal number of male and female learners in Grade 6 suggests that both boys and girls have equitable access to education, aligning with the equity dimension of

SDG 4.1. However, the small cohort sizes also reflect the multigrade and low-enrolment nature of the school, which can influence learning conditions through limited peer interaction, combined classes, and shared teacher attention. While the enrolment data indicate that access to free primary education is being met, further analysis is needed to determine whether these learners are achieving relevant and effective learning outcomes, which is the core metric of SDG Target 4.1.

- **SDG 4 Performance in Terms of Learning Outcomes of the Identified Last Mile School (LMS)** *(4.1.1.b: Proportion of Children and Young People at the End of Primary School Achieving at Least a Minimum Proficiency Level)*

Table 3. Philippine Informal Reading Inventory Group Screening Test (Grade 4, 5 & 6)*

Grade 4 (15 Learners)

Interpretation	Male	Female	Total	Percentage
Frustration	4	4	8	53.33%
Instructional	4	2	6	40.00%
Independent/GST Passed	1	0	1	6.67%
Total	9	6	15	100%

Male: 9/15 = 60%; Female: 6/15 = 40%

Grade 5 (14 Learners)

Interpretation	Male	Female	Total	Percentage
Frustration	1	0	1	7.14%
Instructional	2	6	8	57.14%
Independent/GST Passed	3	2	5	35.71%
Total	6	8	14	100%

Male: 6/14 = 42.86%; Female: 8/14 = 57.14%

Grade 6 (20 Learners)

Interpretation	Male	Female	Total	Percentage
Frustration	7	7	14	70.00%
Instructional	3	3	6	30.00%
Independent/GST Passed	0	0	0	0.00%
Total	10	10	20	100%

Male: 10/20 = 50%; Female: 10/20 = 50%

**Conducted June 17, 2025*

Phil-IRI oral reading rating scale (Department of Education)

Oral Reading Level	Word Reading Score-Fluency (%)	Comprehensive Score
Independent	97-100	14-20
Instructional	90-96	9-13
Frustration	89 and below	0-8

Under SDG Indicator 4.1.1.b, learners are considered to have achieved minimum proficiency if they demonstrate the expected foundational reading competencies at the end of primary education. In this assessment, learners categorized as Independent/GST Passed were considered to have met the minimum proficiency level. The Grade 4 Philippine Informal Reading Inventory (Phil-IRI) Group Screening Test (Table 1) results provide crucial insight into SDG Indicator 4.1.1.b, which measures the proportion of children

achieving at least a minimum proficiency level at the end of primary schooling. At the identified LMS, the data reveal significant challenges in foundational literacy. Of the 15 Grade 4 learners assessed, more than half (8 learners) are at the Frustration Level (Score of 89 and below), meaning they struggle with grade-level texts and cannot comprehend reading material without substantial support. Another six learners fall within the Instructional Level (Score of 90-96), capable of understanding texts only with guided assistance. Critically, only one learner reached the Independent Level (Score of 97-100), demonstrating mastery of grade-appropriate reading skills. This distribution shows that a majority of learners have not yet met the minimum proficiency standards expected by SDG 4.1.1.b. For a multigrade, resource-constrained school, this indicates systemic barriers limited access to reading materials, insufficient remedial instruction time, and competing instructional demands across grade levels. The results underscore an urgent need for targeted reading interventions, strengthened early-grade literacy instruction, and greater instructional support for learners' progress toward meaningful reading proficiency by the end of Grade 4.

Grade 5 demonstrates the most promising literacy performance across all tested grade levels. More than one-third of the learners can already read independently, confidently navigating grade-level texts without teacher assistance. A majority fall under the instructional level, meaning they can comprehend material with strategic guidance, an indicator that their foundational skills are steadily solidifying. The Grade 5 reading assessment results indicate that out of 14 learners assessed, 5 learners (35.71%) achieved the Independent/GST Passed level, which may be interpreted as meeting the minimum proficiency level aligned with SDG Indicator 4.1.1.b. Meanwhile, 8 learners (57.14%) were classified under the Instructional level, suggesting that although these learners possess partial reading competencies, they still require teacher guidance and targeted interventions to attain independent reading proficiency. Only 1 learner (7.14%) fell under the Frustration level, indicating serious difficulty in reading comprehension and decoding skills.

The Grade 6 reading assessment results reveal that out of 20 learners assessed, none achieved the Independent/GST Passed level, indicating that 0% of the learners met the minimum proficiency level associated with SDG Indicator 4.1.1.b. A total of 14 learners (70.00%) were classified under the Frustration level, while 6 learners (30.00%) were categorized under the Instructional level. These findings suggest that the majority of learners experience significant challenges in reading comprehension, fluency, and independent literacy performance expected at the end of primary education. The absence of learners in the Independent/GST Passed category highlights a critical concern regarding learners' attainment of foundational literacy competencies. In the context of SDG 4.1.1.b, the results imply that Grade 6 learners have not yet achieved the expected minimum proficiency standards for reading at the end of primary schooling. The high proportion of learners in the Frustration level underscores the urgent need for intensified literacy interventions, remedial reading programs, differentiated instruction, and strengthened teacher support mechanisms to address persistent learning gaps.

The cross-sectional reading assessment results across Grades 4, 5, and 6 reveal uneven attainment of literacy competencies associated with SDG Indicator 4.1.1.b, which measures the proportion of learners achieving at least minimum proficiency in reading at the end of primary education. Grade 5 learners demonstrated the strongest performance, with 35.71% achieving the Independent/GST Passed level, while Grade 4 recorded only 6.67% and Grade 6 recorded no learners meeting the minimum proficiency benchmark. Most Grade 4 learners (53.33%) and Grade 6 learners (70.00%) performed at the Frustration level, whereas the majority of Grade 5 learners (57.14%) remained at the Instructional level, indicating partial mastery that still required teacher support. In relation to SDG 4, the results indicate that a substantial proportion of learners remain at risk of completing primary school without foundational literacy competencies necessary for lifelong learning and academic success. The concentration of learners in the Frustration and Instructional levels may therefore reflect systemic gaps in early literacy intervention, differentiated instruction, and sustained learner support. Improving SDG 4 attainment requires coordinated and multi-level interventions that strengthen foundational reading instruction, enhance teacher capacity, improve resource allocation, and establish continuous literacy support mechanisms throughout the primary years.

Table 4. Numeracy Profile

Grade	Sex	Total Assessed	Emerging (Not Proficient)	%	Emerging (Low Proficient)	%	Developing (Nearly Proficient)	%	Transitioning (Proficient)	%	At Grade Level (Proficient)	%
4	M	9	1	11.11%	2	22.22%	6	66.67%	0	0	0	0
	F	6	0	0.00%	2	33.33%	4	66.67%	0	0	0	0
	Total	15	1	6.67%	4	26.67%	10	66.67%	0	0	0	0
5	M	6	0	0.00%	5	83.33%	1	16.67%	0	0	0	0
	F	8	0	0.00%	7	87.50%	1	12.50%	0	0	0	0
	Total	14	0	0.00%	12	85.71%	2	14.29%	0	0	0	0
6	M	10	1	10.00%	9	90.00%	0	0.00%	0	0	0	0
	F	10	1	10.00%	8	80.00%	1	10.00%	0	0	0	0
	Total	20	2	10.00%	17	85.00%	1	5.00%	0	0	0	0

The numeracy assessment (Table 4) at the identified LMS highlights serious challenges in learners' mastery of fundamental mathematical concepts across all grade levels. In Grade 4, most learners are classified as emerging or low proficient, with none achieving grade-level proficiency. This indicates difficulties in understanding basic operations, number sense, and problem-solving skills. Grade 5 shows a similar pattern, with the majority of learners still at the emerging or low proficient level and only a few approaching developing proficiency. By Grade 6, the situation becomes critical: nearly all learners remain low proficient, and none have reached grade-level proficiency. This trend reflects weak foundational numeracy skills, poor mastery of computations, and significant struggles with multi-step problems. The differences in proficiency from lower to upper grades suggests varying learning losses, likely exacerbated by the multigrade instructional setup, limited access to learning resources, interruptions in schooling (including pandemic-related disruptions), and socio-economic constraints typical of LMS. These findings underscore the urgent need for targeted remedial instruction, differentiated teaching strategies, and structured support to strengthen learners' numeracy skills and prevent further gaps in mathematical competence.

The cross-sectional numeracy assessment results across Grades 4, 5, and 6 reveal substantial variation in learners' proficiency levels among different grade cohorts assessed during the same period. Grade 4 learners demonstrated relatively stronger numeracy performance, with 66.67% classified under the Developing (Nearly Proficient) level and no learners categorized as proficient. In contrast, Grade 5 learners were predominantly concentrated in the Emerging (Low Proficient) category (85.71%), while only 14.29% reached the Developing level. Similarly, Grade 6 learners showed a high concentration in the Emerging (Low Proficient) category (85.00%), with only 5.00% categorized as Developing and 10.00% remaining at the Emerging (Not Proficient) level. These findings indicate that numeracy competencies vary across grade-level cohorts and suggest uneven acquisition of foundational mathematical skills among learners within the school context. In relation to SDG 4, particularly SDG Indicator 4.1.1.b, the findings raise concerns regarding learners' attainment of minimum proficiency in mathematics at the end of primary education. The absence of learners classified under the Transitioning (Proficient) and At Grade Level (Proficient) categories across all grade levels suggests that many learners may struggle to achieve the foundational numeracy competencies necessary for academic progression, lifelong learning, and meaningful participation in society. Improving numeracy outcomes and advancing SDG 4 require integrated interventions that strengthen foundational mathematics instruction, promote equitable access to learning resources, support teacher development, and establish sustained learner support mechanisms across primary education contexts.

3.2. Understanding How the Current Conditions of the Identified Last Mile School Impact its SDG 4 Performance Using Systems Thinking Framework

The current condition of the LMS in terms of SDG 4 means of implementation and learning outcomes can be understood through systems thinking model (Figure 4). The study applied systems thinking as an analytical and methodological framework to examine how interconnected structural, institutional, and socio-ecological conditions shape SDG 4 performance in the identified Last Mile School (LMS). Rather than interpreting literacy and numeracy outcomes as isolated indicators of learner ability, the study positions the LMS as a complex socio-ecological system composed of interacting subsystems, including infrastructure, instructional practices, teacher workload, learner conditions, governance structures, and community contexts. Systems thinking enabled the study to identify how relationships among these components generate reinforcing and balancing feedback loops that influence educational quality and learning outcomes. The framework guided the integration of qualitative school-context data, institutional observations, and learner performance results to explain how systemic interactions produce persistent educational constraints. In the LMS context, inadequate infrastructure, including the absence of libraries, laboratories, disability-inclusive facilities, and technology resources, constrained instructional delivery and reduced opportunities for diversified learning experiences, thereby reinforcing low learner engagement and weak proficiency outcomes. Similarly, teacher overload in multigrade settings created balancing loops in which increasing administrative and community-related responsibilities reduced instructional focus and individualized learner support, which subsequently intensified remediation demands and further increased teacher burden. The framework also allowed the study to interpret literacy and numeracy findings cross-sectionally by examining how different learner cohorts experienced varying combinations of instructional conditions, resource limitations, and socio-economic pressures within the same educational system. Instead of attributing performance variation solely to grade level differences, systems thinking revealed how multiple interacting conditions collectively shape learner outcomes across cohorts. Geographic isolation, poverty, limited household learning support, and weak institutional assistance functioned as external stressors that amplified instructional difficulties and constrained the school's capacity to achieve SDG 4 targets. Through this methodological lens, the study identified institutional support and resource allocation as critical leverage points capable of influencing broader system behavior and educational resilience. In sustainability science, this approach aligns with the recognition that educational quality emerges from dynamic interactions between social, institutional, environmental, and governance systems rather than from isolated educational inputs alone. The study demonstrates that improving SDG 4 attainment in LMS contexts requires integrated, system-wide interventions that simultaneously address infrastructure deficits, teacher support, community conditions, and governance mechanisms to strengthen long-term educational resilience and sustainability.

3.2.1. Infrastructure Deficits as a Structural Constraint (SDG 4.a) The elementary school exhibits characteristics typical of Last Mile Schools (LMS), including multigrade classes, nonstandard infrastructures, limited electricity-dependent resources, absence of a library and laboratory, makeshift canteen, and no disability-inclusive facilities. These deficits directly constrain instructional delivery and indirectly affect learner engagement. A reinforcing loop emerges whereby poor infrastructure limits instructional strategies, weakening learning experiences, reducing learner proficiency, and decreasing motivation, thereby perpetuating poor outcomes (DepEd, 2019; EDCOM, 2025). The lack of computers, internet access, and adapted learning materials forms systemic barriers to SDG 4.a's vision of "*effective, inclusive learning environments*" (Albert et al., 2023; Wiek et al., 2011). Even where electricity is available, its educational utility remains minimal due to the absence of equipment, highlighting the school's low resilience and reliance on external support (Meadows, 2008; Redman & Miller, 2023).

3.2.2. Teacher Overload and Multigrade Pressures (SDG 4.c) The LMS teachers are fully licensed but face substantial non-teaching workloads, including administrative tasks, community outreach, school events, facility maintenance, and coordination with local government units. With eight teachers handling multigrade classes and multiple responsibilities, actual teaching time is reduced, creating a balancing loop that suppresses educational quality: additional non-teaching roles decrease instructional focus, reduce individualized teaching

for struggling students, lower performance, and increase teacher burden due to remediation demands (David et al., 2019; Albert et al., 2023). From a sustainability science perspective, this misalignment between mandated and actual teacher roles represents institutional inefficiency, compromising long-term educational quality (Wiek et al., 2011; Redman & Miller, 2023).

3.2.3. Multigrade Structure and Learning Loss (SDG 4.1) Multigrade teaching requires advanced planning and differentiated instruction, but the LMS faces scarce teaching materials, few reference books, no library, and limited quiet learning space. Consequently, learning time is fragmented across grade levels, constraining opportunities for sustained instructional support. Reading literacy performance varies across grade-level cohorts. In Grade 4, the majority of learners are at the frustration level; Grade 5 exhibits relatively stronger performance; whereas Grade 6 records the lowest reading proficiency, with nearly all learners classified at the frustration level. Numeracy shows a comparable pattern, with no learners in Grades 5 and 6 attaining the expected proficiency levels. These pattern follows the learning loss trend reported by DepEd Region VI (2022 and Albert et al. (2023). While these data are cross-sectional and do not represent the progression of the same learners over time, the observed cohort-level differences suggest persistent challenges in developing and sustaining foundational literacy and numeracy competencies within the school system. From a systems perspective, these patterns indicate limited capacity to regenerate and strengthen learning outcomes under existing resource constraints, reflecting low systemic resilience (Meadows, 2008; Redman & Miller, 2023).

3.2.4. Socioeconomic and Geographic Barriers as External Stressors The LMS is situated in a remote barangay with rough terrain access, and most learners come from low-income households reliant on seasonal labor. These factors affect attendance, readiness to learn, and home literacy support, while LMS communities often lack reading materials and internet access, limiting learning opportunities outside school (UNICEF Philippines, 2023; World Bank, 2022). This external environment creates a pressure loop: low socioeconomic conditions limit home learning support, leading to weaker literacy and numeracy, higher remediation demand, and increased instructional strain on multigrade teachers. These findings indicate that learning outcomes are embedded within a broader socio-ecological system (Ishii & Tilbury, 2021; Redman & Miller, 2023).

3.2.5. Weak Institutional Support as a Systemic Leverage Gap The elementary school status as a Last Mile School highlights persistent gaps in institutional response. Despite national LMS programs, the school shows no computer for pedagogical purposes, lacks key facilities, and continues to rely on makeshift structures (DepEd, 2019; COA, 2024). Delayed or insufficient central support generates chronic resource deprivation and sustained learning inequities. From a sustainability science perspective, institutional governance is a critical system component, and its weakness constrains overall resilience (EDCOM, 2025; Wiek et al., 2011). Empirical data from PIDS (2023), DepEd (2019), and EDCOM (2025) confirm that despite nationwide gains in enrollment and policy reforms, the Philippines continues to struggle with a “learning poverty” crisis especially in remote and underserved areas. The documented national patterns of infrastructure shortfalls, teacher overload, and weak institutional support resonate strongly with the on-the-ground realities observed in the identified LMS. By situating this study within the broader national context, the research underscores how systemic, structural, and socio-ecological factors intersect to shape educational outcomes. The patterns observed at the LMS echo PIDS’s (2023) recommendation for holistic, integrated interventions from resource allocation and teacher support to community involvement and infrastructure development.

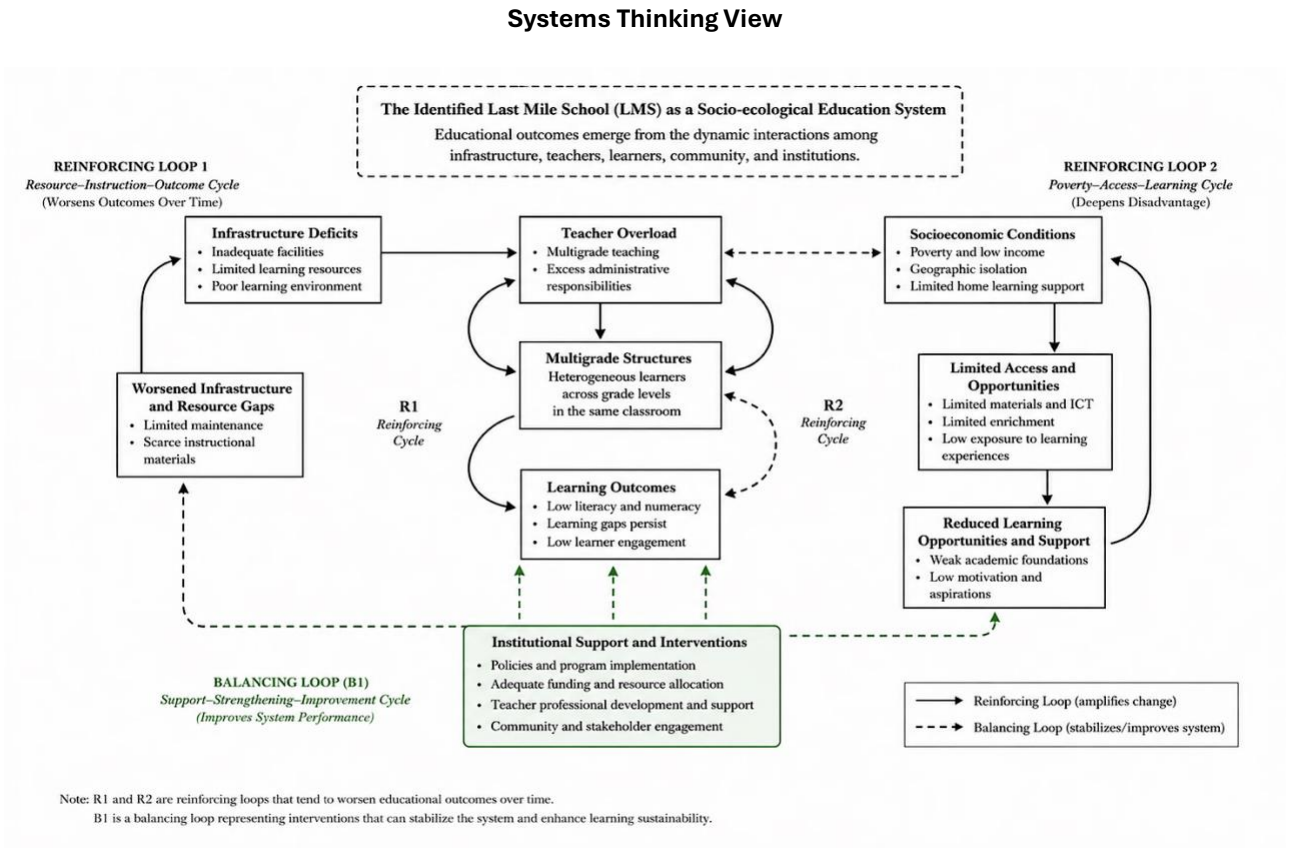

Figure 4. Systems Thinking View of the Socio-Ecological Factors at Last Mile School (LMS)

Figure 4 illustrates the identified Last Mile School (LMS) as a socio-ecological educational system in which infrastructure conditions, teacher workload, multigrade instructional contexts, learner conditions, socioeconomic realities, and institutional support interact to shape SDG 4 outcomes. The model highlights how infrastructure deficits, multigrade instructional pressures, and socioeconomic barriers collectively contribute to weak literacy and numeracy outcomes, while limited institutional support reinforces persistent educational inequities. Using a systems thinking lens, the figure demonstrates that educational challenges in economically disadvantaged school emerge from interconnected structural and contextual factors rather than from isolated learner-level deficiencies alone. Physical infrastructure limitations, such as nonstandard classrooms, lack of libraries and laboratories, and insufficient electricity-dependent resources, constrain instructional strategies and diminish learner engagement (DepEd, 2019; EDCOM, 2025). These constraints are amplified by teacher workload and multigrade pressures, which reduce individualized support and heighten remediation demands, thereby reinforcing learning loss (David et al., 2019; Albert et al., 2023). Learners' socioeconomic and geographic realities including low household income, seasonal labor dependence, and limited access to reading materials exacerbate instructional challenges and reduce home learning support, creating external stressors that feed back into the system (UNICEF Philippines, 2023; World Bank, 2022). Weak institutional support, reflected in delayed construction, resource gaps, and limited policy implementation, serves as a systemic bottleneck, curbing the capacity of the school to adapt and recover from these compounded pressures (COA, 2024; EDCOM, 2025). These interrelated subsystems illustrate a reinforcing cycle of structural constraints, pedagogical strain, and socio-ecological pressures that collectively undermine SDG 4 targets, particularly literacy and numeracy outcomes (Albert et al., 2023; Wiek et al., 2011). By framing LMS as a socio ecological system, the study highlights that improvements in SDG 4 performance require integrated interventions targeting infrastructure, teacher capacity, multigrade pedagogy, socioeconomic support, and institutional governance, rather than isolated solutions, thereby providing actionable insights for policy and practice in Last Mile Schools. Thus, this case study does not merely provide a localized description, it contributes to a deeper understanding of how national-level educational inequities documented by PIDS, EDCOM, and DepEd manifest in Last Mile Schools, and how systemic reform, guided by a socio-ecological lens, may be necessary to meaningfully advance SDG 4 in marginal contexts.

3.3. Building Sustainable Education Toward SDG 4 Through the Six Sustainability Capacities of Clark and Harley (2020)

Clark and Harley (2020) identified six key sustainability capacities: (1) the capacity to measure progress through reliable and context-sensitive evidence; (2) the capacity to promote equity by addressing structural inequalities; (3) the capacity to adapt to changing social, environmental, and institutional conditions; (4) the capacity to transform systems through long-term structural change; (5) the capacity to link knowledge with action through evidence-based decision-making; and (6) the capacity to govern cooperatively through collaboration among institutions, communities, and stakeholders. The study used these six sustainability capacities as the final interpretive framework in the analytical section to synthesize the findings and derive sustainability-oriented recommendations for the identified Last Mile School (LMS). After examining literacy and numeracy outcomes, infrastructure conditions, teacher workload, multigrade instructional pressures, socioeconomic barriers, and institutional support, the framework enabled the study to interpret these issues not as isolated educational problems but as interconnected socio-ecological conditions affecting SDG 4 attainment. Specifically, the capacities guided the analysis in identifying how the LMS can strengthen context-sensitive educational monitoring (capacity to measure progress), address structural inequities affecting marginalized learners (capacity to promote equity), improve resilience to disruptions and learning loss (capacity to adapt), implement systemic and long-term reforms (capacity to transform), connect research evidence with policy and school-level action (capacity to link knowledge with action), and strengthen collaboration among schools, communities, local governments, and other stakeholders (capacity to govern cooperatively). Through this framework, the study generated integrated and systems-oriented recommendations aimed at improving educational quality, resilience, and sustainability in geographically isolated LMS contexts. The findings of this study reveal that the educational challenges experienced by the identified Last Mile School (LMS) are not merely instructional or infrastructural concerns, but manifestations of deeper socio-ecological and institutional sustainability issues. Viewed through the sustainability science framework (Figure 5) of William C. Clark and Alicia G. Harley (2020), the school's weak SDG 4 performance reflects deficiencies in the interconnected capacities necessary to build sustainable and equitable educational systems. Clark and Harley (2020) argued that sustainability is achieved not through isolated interventions but through the strengthening of systemic capacities that enable societies to respond adaptively, equitably, and collaboratively to persistent challenges. In the context of Last Mile Schools, sustainable education therefore requires integrated reforms that simultaneously address infrastructure, governance, pedagogy, equity, community participation, and institutional resilience.

3.3.1. Capacity to Measure Sustainable Development Goal 4 The first sustainability capacity emphasizes the ability of government's education department to generate reliable, context-sensitive, and actionable evidence for monitoring sustainability outcomes and informing adaptive decision-making (Clark & Harley, 2020). This study strengthens that capacity by producing localized evidence on literacy and numeracy proficiency, instructional conditions, teacher workload, infrastructure limitations, and socio-ecological vulnerabilities within a geographically isolated Last Mile School (LMS). The findings reveal substantial gaps in SDG 4 attainment, particularly the absence of learners achieving independent reading proficiency in Grade 6 and the lack of grade-level numeracy proficiency across the upper elementary cohorts. These results demonstrate that measuring educational sustainability through enrollment participation or school access indicators alone obscures persistent learning inequities and masks systemic instructional challenges within remote schools. The study therefore supports the need to institutionalize sustainability-oriented educational monitoring systems that assess not only participation rates but also learning quality, instructional resilience, teacher support conditions, and contextual barriers affecting educational outcomes. The integration of systems thinking and mapping enabled the study to identify reinforcing feedback loops linking infrastructure deficits, multigrade instructional pressures, limited professional support, socio-economic disadvantage, and weak learner proficiency outcomes. This approach highlights how educational underperformance in LMS contexts emerges from interconnected structural and institutional conditions rather than isolated learner-level deficiencies. The study recommends that policymakers, school leaders, and education agencies adopt integrated evidence-based planning frameworks capable of capturing the dynamic relationships among learning conditions, governance support, and community contexts. Strengthening data systems through localized, context-responsive educational assessment can help identify high-impact leverage points, improve

resource prioritization, prevent fragmented interventions, and support more adaptive and sustainable strategies for achieving SDG 4 in geographically marginalized communities.

3.3.2. Capacity to Promote Equitable and Inclusive Education The study demonstrates that achieving educational sustainability requires addressing the structural inequities that disproportionately affect geographically isolated and marginalized communities. The identified Last Mile School (LMS) experiences intersecting disadvantages associated with geographic isolation, poverty, limited institutional reach, and constrained educational resources, all of which directly affect SDG 4 attainment. Learners face unequal access to libraries, laboratories, ICT facilities, disability-inclusive infrastructure, contextualized instructional materials, and stable learning environments. These inequities extend beyond physical access and influence instructional quality, learner engagement, literacy and numeracy development, and overall educational participation. The findings therefore support the need for equity-oriented and justice-based educational interventions that prioritize LMS contexts in infrastructure investment, digital connectivity expansion, instructional resource allocation, and teacher support systems. In sustainability science, inclusive education emerges not merely from standardized policy implementation but from the ability of educational systems to recognize and respond to the differentiated realities of marginalized learners and communities. Educational sustainability becomes possible when policymakers and institutions position geographically isolated learners not as peripheral beneficiaries but as central participants in educational transformation and SDG 4 implementation.

3.3.3. Capacity to Adapt The findings reveal that the identified LMS possesses limited adaptive capacity due to fragile infrastructure, constrained instructional resources, multigrade instructional pressures, and insufficient institutional support mechanisms. Geographic isolation, inaccessibility, poverty, and resource scarcity collectively reduce the school's ability to sustain learning continuity during disruptions such as extreme weather events, economic instability, and post-pandemic recovery conditions. The cross-sectional literacy and numeracy results indicate persistent learning gaps across learner cohorts, suggesting that the school system struggles to absorb and remediate accumulated learning difficulties effectively. These findings support the need for adaptive educational systems capable of responding proactively to changing and uncertain conditions through flexible learning delivery mechanisms, context-responsive multigrade pedagogy, localized remediation strategies, and community-supported learning ecosystems. The study further highlights the importance of strengthening disaster-resilient infrastructure, digital learning preparedness, decentralized instructional support, and school-community coordination to reduce institutional vulnerability. Adaptive capacity depends on the ability of educational systems to reorganize, respond, and maintain instructional continuity under stress while protecting long-term learning outcomes and educational resilience.

3.3.4. Capacity to Transform The study demonstrates that the challenges confronting the LMS are systemic, interconnected, and self-reinforcing, thereby requiring transformative rather than incremental responses. Infrastructure limitations intensify teacher workload, teacher overload constrains instructional quality, weak instructional conditions contribute to low learner proficiency, and poor learning outcomes subsequently increase remediation demands and instructional strain. These reinforcing feedback loops reproduce educational vulnerability and constrain SDG 4 attainment across the school system. The findings therefore indicate that isolated interventions, such as classroom construction alone or short-term remediation programs, remain insufficient for addressing the structural roots of educational inequity in geographically marginalized contexts. Instead, the study supports transformative reforms that redesign multigrade instructional systems, institutionalize sustained literacy and numeracy recovery programs, strengthen teacher support mechanisms, reduce administrative burdens, and establish integrated school-community support structures. The systems thinking framework used in the study demonstrates methodologically that educational transformation occurs when institutions simultaneously address interconnected leverage points rather than implementing fragmented interventions. Transformative capacity requires educational systems to restructure governance arrangements, resource flows, instructional practices, and institutional priorities in ways that strengthen long-term educational resilience, equity, and sustainability.

3.3.5. Capacity to Link Knowledge with Action The study highlights the importance of bridging research evidence and practical educational decision-making to strengthen SDG 4 implementation in Last Mile Schools. Although national LMS policies and educational programs exist, the findings reveal persistent implementation gaps reflected in incomplete facilities, inadequate instructional resources, weak institutional support, and sustained learning inequities. These conditions demonstrate that policy existence alone does not guarantee effective local implementation or improved learning outcomes. By integrating localized evidence, systems mapping, and contextualized analysis, the study illustrates how sustainability-oriented educational research can support more responsive and actionable planning processes. The findings therefore support the institutionalization of evidence-based educational governance that continuously incorporates local school realities, learner conditions, teacher experiences, and community contexts into policy implementation and resource allocation decisions. The study also emphasizes the need for stronger collaboration among researchers, schools, local government units, policymakers, and communities to ensure that interventions remain context-sensitive and operationally feasible. Linking knowledge with action requires continuous feedback between evidence generation, policy adaptation, and implementation practice so that educational systems can respond dynamically to evolving local conditions and sustainability challenges.

3.3.6. Capacity to Govern Cooperatively The findings indicate that sustainable educational delivery in LMS contexts depends heavily on cooperative governance and collective institutional action. The identified LMS operates within a constrained institutional environment in which teachers simultaneously perform instructional, administrative, coordination, and community engagement functions due to limited personnel and weak systemic support. This concentration of responsibilities reduces instructional focus and limits the school's overall operational resilience. The study therefore supports governance arrangements that distribute educational responsibilities across multiple actors, including educational institutions, local government units, civil society organizations, community stakeholders, and external development partners. Cooperative governance can strengthen educational sustainability by supporting community-based literacy initiatives, localized remediation programs, school maintenance assistance, nutrition and health partnerships, and decentralized instructional support systems. In geographically isolated and Indigenous contexts, participatory governance mechanisms can also strengthen cultural responsiveness, local ownership, and long-term sustainability of educational interventions. From a sustainability science perspective, cooperative governance enhances system resilience by mobilizing diverse forms of institutional, social, and community capacity to collectively address complex and interconnected educational challenges associated with SDG 4 attainment.

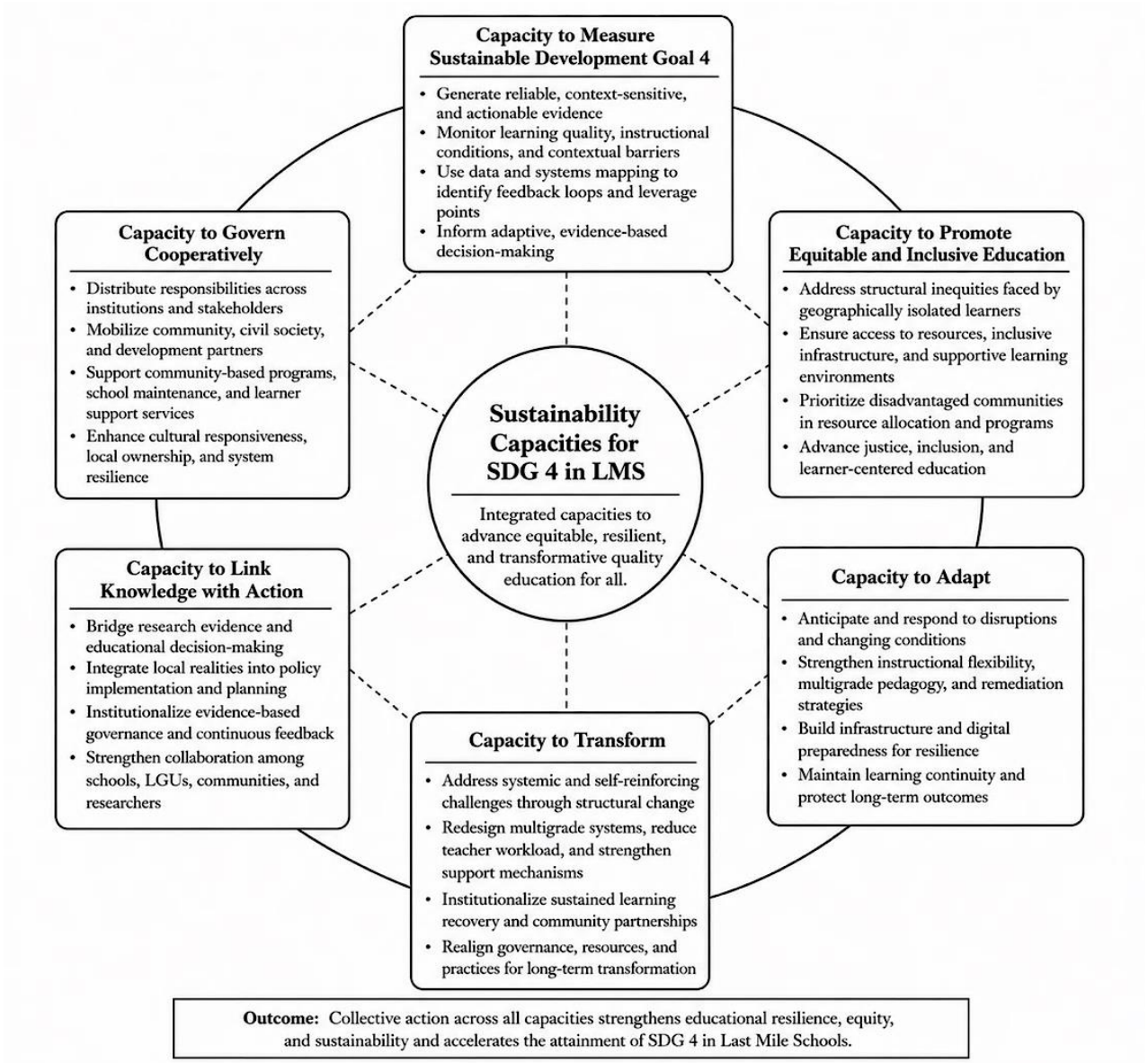

Figure 5. Six capacities necessary for sustainable education in the LMS adapted from Clark and Harley (2020)

The six sustainability capacities of Clark and Harley (2020) demonstrate that achieving SDG 4 in the identified Last Mile School (LMS) requires integrated, context-responsive, and system-oriented interventions rather than isolated or short-term solutions. The findings reveal that educational outcomes in the LMS emerge from the interaction of infrastructure limitations, multigrade instructional pressures, teacher workload, socio-economic disadvantage, geographic isolation, and weak institutional support systems. Through systems thinking, the study identified how these interconnected conditions generate reinforcing feedback loops that constrain literacy and numeracy proficiency, weaken instructional resilience, and sustain educational inequities across learner cohorts. At the same time, the study highlights several critical intervention points that can support sustainability-oriented educational reform within the identified LMS. These include strengthening localized educational monitoring systems that assess actual learning quality rather than enrollment alone; prioritizing equitable provision of instructional resources, disability-inclusive facilities, and contextualized learning materials; expanding access to multigrade-responsive professional development, instructional coaching, and workload protection for teachers; improving adaptive learning support mechanisms and community-based remediation programs; institutionalizing evidence-based and participatory educational planning; and strengthening cooperative governance among the school, local government units, families, and community stakeholders. The findings further suggest that sustainable educational improvement in the identified LMS depends on the capacity of institutions to respond adaptively to local socio-ecological realities

while ensuring that marginalized learners remain central to policy implementation and resource allocation. The study recommends that interventions in the identified LMS move beyond fragmented infrastructure provision and instead adopt coordinated, systems-based strategies that simultaneously address instructional quality, institutional support, community participation, and long-term educational resilience in support of SDG 4 attainment.

4. Conclusions

This study examined how socio-ecological factors such as institutional and instructional conditions shape Sustainable Development Goal 4 (SDG 4) attainment in an identified Last Mile School (LMS) in Iloilo Province. The findings showed that persistent literacy and numeracy gaps, inadequate infrastructure, multigrade instructional pressures, excessive non-teaching responsibilities, limited instructional resources, and weak institutional support collectively constrained the school's capacity to provide inclusive and quality education. These conditions did not operate independently. Instead, they interacted within a broader socio-ecological system where geographic isolation, poverty, governance limitations, and unequal access to educational opportunities reinforced educational vulnerability and weakened learner outcomes. The study contributes to sustainability science and educational research by extending socio-ecological systems thinking into the analysis of educational inequities in geographically marginalized school contexts. By integrating systems thinking with the six sustainability capacities of Clark and Harley (2020), the study developed a sustainability-oriented framework for interpreting SDG 4 attainment beyond conventional enrollment- and access-based indicators. The framework enabled the study to explain how infrastructure conditions, governance arrangements, teacher workload, learner realities, and community contexts dynamically interact to shape educational quality and resilience. The study demonstrated how systems mapping and sustainability capacities can serve as analytical tools for identifying reinforcing and balancing feedback mechanisms that influence educational outcomes in remote schools. The findings also carry important practical implications for policymakers, school leaders, and local government units. The study highlights the need to move beyond fragmented and infrastructure-centered interventions toward integrated and context-responsive educational reforms. Strengthening SDG 4 attainment in LMS contexts requires localized educational monitoring systems, sustained literacy and numeracy recovery programs, multigrade-responsive instructional support, workload protection for teachers, disability-inclusive infrastructure, adaptive learning systems, and stronger school-community partnerships. The findings further emphasize the importance of participatory and evidence-based governance mechanisms that incorporate local socio-ecological realities into educational planning, implementation, and resource allocation. However, the study focused on a single LMS case in Iloilo Province, which limits the transferability of the findings across other geographically isolated schools with different socio-cultural and institutional conditions. The study also relied primarily on qualitative institutional analysis and school-level literacy and numeracy assessment data, limiting broader statistical generalization. In addition, the cross-sectional data captured learner cohorts at one point in time and therefore could not examine long-term changes in educational outcomes. The study concentrated mainly on school-level conditions and did not extensively examine household educational practices, learner psychosocial factors, or wider regional governance dynamics that may also shape SDG 4 performance. Future studies may address these limitations by conducting comparative Last Mile School analyses across regions, integrating longitudinal and mixed-methods approaches, and examining how governance systems, community conditions, and socio-ecological factors interact over time to influence sustainable educational outcomes in marginalized settings.

Acknowledgments The authors sincerely express their profound gratitude to the LMS for generously granting permission to access and utilize the relevant secondary data essential to the completion of this study.

Funding This study did not receive any financial support or funding from public, private, commercial, or non-profit funding agencies.

Data Availability The data supporting the findings of this study, including proficiency and numeracy performance data, are available from the authors upon reasonable request.

Declarations

Competing Interests The authors declare no competing interests.

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Ethical Consideration This study complied with all applicable ethical standards and requirements and was duly reviewed and approved by the research committee.

AI Use The figures used in this study were enhanced using artificial intelligence-assisted tools. The authors carefully verified and ensured the accuracy, consistency, and integrity of all details presented in the figures.

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