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Experiences and challenges of teaching elementary science in last-mile schools

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Abstract

This study explores the challenges faced by science educators in last-mile schools in Ilocos Norte, Philippines, particularly during the COVID-19 pandemic. Using a Participatory Action Research (PAR) approach based on Pakasaritaan Theory, the study examines how cultural and contextual factors influence science teaching and learning. Data were collected through semi-structured interviews, classroom observations, and focus group discussions with science teachers and school administrators. Findings reveal that while students demonstrate foundational scientific knowledge, they struggle with higher-order cognitive skills such as retention, reasoning, and real-world application. Key barriers include limited laboratory facilities, insufficient teacher training, and infrastructure deficiencies, which hinder effective science instruction. To address these challenges, educators implemented localized teaching strategies, flexible learning modalities, and community-based resource utilization. The study highlights the importance of culturally responsive pedagogies, sustained teacher capacity building, and the integration of Sustainable Development Goals (SDGs) into science curricula to enhance learning in underserved areas. These findings offer insights into policy recommendations and faculty development programs that support meaningful and sustainable science education in last-mile schools.

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Introduction

There are several concerns regarding the services offered to pupils in science classes, especially with the focus on a curriculum that considers policy and cultural contexts for diverse learners. Primary schools have shown that students' scientific literacy is high, yet challenges remain in teaching science effectively. The laboratory method, which emphasizes hands-on activities, is essential for deeper learning, but its implementation is inconsistent.

The Department of Education (2020) has responded by launching the Last Mile School Program, which targets schools in underserved areas, including those with Indigenous Peoples (IP). This program, focused on improving facilities, infrastructure, and teacher capacity, seeks to address disparities in science education. However, more efforts are needed to ensure these improvements translate into better learning outcomes. On the other hand, science education plays a crucial role in shaping informed citizens and driving sustainable development. However, in last-mile schools—those in geographically isolated and underserved communities—delivering quality science instruction remains a significant challenge.

Despite efforts to improve education access, last-mile schools continue to experience limited resources, insufficient teacher training, and infrastructure deficiencies, which directly affect students' ability to engage with science. While students demonstrate foundational scientific knowledge, they struggle with retention, reasoning, and applying concepts to real-world situations. This raises concerns about whether their scientific literacy translates into meaningful understanding. Furthermore, the Philippines' low performance in the 2019 PISA assessment highlights gaps in students' analytical and problem-solving skills, reinforcing the urgency of addressing these challenges.

On the other hand, process skills are essential for scientific inquiry, enabling students to observe, classify, measure, infer, predict, experiment, and communicate. These skills are fundamental in fostering critical thinking and problem-solving abilities in science education. However, in last-mile schools, the lack of laboratory facilities, inadequate teacher training, and resource limitations hinder the development of these skills. The Alternative Learning System (ALS) introduced by the Philippine Statistics Authority (2019) emphasizes the importance of process skills in bridging educational gaps, advocating for alternative learning approaches in disadvantaged areas. As last-mile schools continue to face these constraints, innovative teaching strategies—such as using household materials and integrating community resources—are essential in promoting scientific literacy and inquiry-based learning.

The study aligns with the Sustainable Development Goals (SDGs), particularly SDG 4.7, which promotes education for sustainable development. Teachers in last-mile schools must integrate locally relevant, culturally sensitive teaching methodologies to make science education more accessible and applicable. This study explores how educators incorporate flexible learning modalities, community-based resources, and SDG-aligned science instruction to address these persistent challenges.

This study actively involves educators in developing practical solutions, rather than merely analyzing their challenges. The findings will inform future educational policies and training programs, ensuring that science education in last-mile schools is not only accessible but also meaningful and impactful.

This study investigates the key challenges faced by science teachers in last-mile schools, particularly in instructional strategies, resource availability, and student engagement. Given the limitations in infrastructure, internet access, and laboratory facilities, teachers adopt alternative methods to enhance science learning. It also examines the role of community engagement, exploring how partnerships with parents, local leaders, and stakeholders contribute to student learning. By analyzing these adaptive strategies, the study provides insights into culturally responsive teaching and localized interventions, aiming to develop sustainable solutions that improve science education outcomes in underserved areas.

Literature Review

Science education in last-mile schools faces persistent challenges due to limited resources, inadequate teacher training, and infrastructure deficiencies, which hinder students' engagement and scientific literacy (UNESCO, 2023). Research highlights that inquiry-based and hands-on learning approaches significantly enhance students' critical thinking and problem-solving skills (OECD, 2019). However, the lack of well-equipped laboratories and digital learning tools in rural schools prevents the effective implementation of these methods (DepEd, 2020). To address this, community-based interventions and localized teaching strategies have emerged as effective approaches, enabling educators to integrate indigenous knowledge and household materials into science instruction (Morris et al., 2019).

Teacher training remains a crucial factor in improving science education outcomes. Studies emphasize the need for continuous professional development focused on culturally

responsive teaching, digital integration, and resource-based instruction (Mahmud et al., 2018). Moreover, stronger partnerships between schools, local governments, and higher education institutions can enhance access to training, mentorship, and teaching materials (Harris & Hodges, 2023). The expansion of national programs, such as the Last Mile School Program, is vital in sustaining long-term improvements in teacher capacity, infrastructure, and digital accessibility for rural schools (DepEd, 2020).

Technology integration is also seen as a promising solution to bridge educational gaps in underserved areas. Studies show that mobile learning, educational television, and virtual laboratories can supplement traditional instruction, particularly in schools with limited physical resources (World Bank, 2023). However, many last-mile schools struggle with poor internet connectivity and lack of digital devices, making widespread technology adoption challenging (Asian Development Bank, 2023). Addressing these issues requires investment in ICT infrastructure, teacher digital literacy training, and policy support to ensure equitable access to technology-driven education (UNICEF, 2023).

Furthermore, community engagement and parental involvement have been identified as key contributors to successful science education in rural areas. Research indicates that when parents and local leaders participate in science learning initiatives, students show higher motivation, improved academic performance, and better problem-solving skills (Orozco & Ramrez, 2024). Programs that foster school-community partnerships, such as science fairs, outreach activities, and mentorship programs, help make science education more relevant, accessible, and culturally responsive (González & González-Espada, 2023). Strengthening these collaborations can lead to more sustainable and impactful science learning experiences in last-mile schools.

Methodology

This study employed Participatory Action Research (PAR) to examine the challenges faced by science educators in last-mile schools. PAR was chosen because it actively involves participants not only in identifying problems but also in co-developing solutions, ensuring findings are relevant and actionable (Bergamin et al., 2019). Grounded in Pakasaritaan Theory, an indigenous Ilokano framework emphasizing local narratives (sarita), the study captured teachers lived experiences, integrating their perspectives into the development of culturally responsive science teaching strategies (Soria, 2012). By utilizing PAR's cyclical action-reflection model, the research ensured an iterative process of problem identification, collaborative solution development, and strategy refinement through participant feedback.

The study was conducted over six months across five last-mile schools in Ilocos Norte, involving 11 elementary science teachers and 5 school administrators, selected through purposive sampling based on their experience in rural education. Data collection followed a three-phase structure. The first phase focused on problem identification, where semi-structured interviews, classroom observations, and focus group discussions (FGDs) were conducted to explore science teaching challenges. The second phase involved collaborative solution development, where teachers and administrators analyzed findings and co-created instructional strategies that integrated localized teaching methods and community-based science resources. The third phase implemented these strategies in classrooms, with biweekly feedback sessions to assess their effectiveness. To ensure data credibility, the study used multiple data sources: recorded interviews transcribed and thematically analyzed, classroom observations documenting teacher-student interactions, FGDs validating emerging themes, and document analysis of school policies and reports.

To enhance the reliability of the semi-structured interview questionnaire, it was validated by five experts with over 15 years of experience in science education and qualitative research. To ensure the reliability of the interview tool, it underwent expert validation, yielding a Content Validity Index (CVI) of 0.89 and Cohen's Kappa coefficient ($\kappa = 0.82$) for inter-rater reliability, with pilot testing refining clarity. The qualitative data collected were analyzed using Braun and Clarke's (2006) thematic analysis framework, involving familiarization with data, coding, identifying and refining themes, and reporting findings. To ensure systematic coding and theme development, the NVivo 12 software was used.

The research design accounted for ethical considerations, with informed consent obtained from all participants and pseudonyms used to ensure confidentiality. While some schools were excluded due to logistical constraints, findings remain relevant to other last-mile schools and similarly under-resourced educational settings. The iterative PAR process allowed participants to engage in meaningful problem-solving rather than serving solely as research subjects, making the study's recommendations practical and scalable for improving science education in marginalized communities.

Results and Discussion

While rural schools may be physically isolated, they offer unique opportunities for science education. Understanding the narratives of last-mile schools is crucial for addressing the challenges they face. The following section presents observations and findings regarding science teaching experiences in last-mile schools in Ilocos Norte.

The study participants were engaged and willing to share their experiences. Their *saritas*, or personal narratives, provided rich insights into the realities of teaching and learning science during the pandemic. The term *saritas* are personal storytelling accounts that enhance the depth of qualitative research. These narratives, along with school documents and observations of physical structures, contributed to a comprehensive understanding of the educational landscape in these schools.

During the interview, the participants were relaxed and ready to answer questions. Their *saritas* produced the depth of the paper, their teaching and learning experiences during the pandemic, their challenges in teaching science, and how they address the challenges of science teaching.

On the other hand, the documents presented and the observed physical structure of the schools were confirmed through the different *sarita* of the teachers and the administrators.

Description of the Teaching and Learning Experiences of the Teachers and School Heads in the Last-Mile Schools during the Pandemic

Education during the pandemic posed numerous challenges, especially in science teaching. Despite rapidly changing learning environments, STEM educators demonstrated resilience and adaptability in assisting students through uncertain times (Young & Garcia, 2020).

Although improving students' scientific literacy is a key goal of K–12 education, the exact definition of scientific literacy remains debated. This presents a critical opportunity for stakeholders to evaluate whether existing curricula adequately equip students with necessary scientific competencies (Morris et al., 2019).

The interview findings provided strong insights into the teachers' experiences in science education during the pandemic. Table 1 presents a thematic analysis based on the focus group discussions with teacher participants.

A review of respondents T11 and T3's coding confirms that both provided similar responses, particularly regarding online lectures and laboratory activities at home, ensuring consistency in coding.

Teachers' experiences highlighted their dedication to achieving learning objectives despite challenges. Online platforms and modular learning were widely used, but internet connectivity issues limited frequent interaction. Teachers compensated by relying on parental assistance and community resources. Flexible learning allowed students to progress at their own pace; however, limited laboratory materials and lack of parental support made experiments challenging. Teachers improvised, using locally available materials to bridge gaps in science education (Chillag, 2020).

Table 2 presents the thematic analysis based on the focus group interview with the school heads.

School heads shared similar observations with teachers regarding the challenges of teaching science during the pandemic. Limited monitoring, reliance on modular learning, and occasional online classes for those with gadgets were common. Parents played a crucial role in assisting their children, but movement restrictions hindered effective hands-on science education.

Explanation of the Challenges of Last-Mile School Teachers and School Heads in Teaching Science

Potential teachers may be frightened by remoteness for other reasons besides only being far from resources that are more readily available in cities or suburbs. Additionally, there is a subconscious notion of remoteness that affects how a rural community is perceived both internally and externally (Harris & Hodges, 2018).

The lack of skilled science teachers, the absence of good textbooks, inadequate supplies, large class sizes, and a lack of administrative support are just a few of the numerous problems facing science education in Philippine schools.

Pupils who had the chance to actively engage in a variety of activities and physically interact with educational materials were considered to be in an effective science classroom. When subjects were required to think deeply and meet high standards for their learning experiences and outcomes, the laboratory approach seemed to be more beneficial (Simon, 2014).

When the researcher visited the schools, the teachers showed their classrooms where laboratory apparatuses were hidden. The problems became more evident due to the pandemic. Table 3 provides the thematic analysis based on the focus group interview with the teacher participants on the challenges of teaching science in the last-mile schools.

Table 1 Thematic analysis based on the focus group interview with the teacher participants on the experiences of science teaching during the pandemic (n = 11)

Sample Questions	Initial Coding/Participants Responses	Code	Subtheme	Theme
How do you facilitate laboratory classes? How do you conduct lecture classes?	*T11:" By using the messenger app through video calls I have to meet my class in order for them to understand the concepts they need to know and develop."*	Laboratory experiences at home Lecture class through a video call Learning by doing Used materials available in the community	Online Modality Available community resources	Flexible Learning
Based on your experiences how do you assess your pupils as to their understanding of Science?	*T8: "Based on my experience they struggle in coping with the subject. Other lessons are too difficult for their understanding. I do it with paper and pencil test."*	Learners are visual and auditory Difficult to learners during experimentation Difficulty in interpreting data Loves to learn but needs help	Difficulty in understanding and learning	Problems, Issues and Concerns in Teaching Science
How do you cope with science teaching in this time of pandemic?	*T3: "By using the messenger app through video calling I have to meet my class in order for them to understand the concepts they need to know and develop."*	Lectures through a video call Laboratory works at home Self-learning modules Internet glitches Educational TV	Home-Based Learning using varied learning modalities	Localization of Materials in Activities

The pandemic created additional difficulties for teachers, particularly when it came to refining students' laboratory abilities since they were unable to see the pupils' hands-on work. Additionally, the last mile school community lacks devices that would enable teachers to readily monitor their students.

Laboratory activities seem to be beneficial for children who scored in the middle to low range on pretest achievement indicators. Fayomi (2017), found that laboratory teaching improved students' capacity to solve issues in physical chemistry and that the laboratory might be a valuable instructional method in chemistry provided experiments were real problems without clear instructions

Laboratory skills are essential for science learners to develop their process skills. Teachers encouraged using available home materials for experiments, ensuring activities promoted basic skills. However, they faced challenges in teaching these skills effectively, as monitoring student progress was difficult. The lack of proper observation during experiments led to gaps in understanding science concepts.

Last-mile schools face numerous barriers to effective science instruction, including a lack of skilled science teachers, inadequate textbooks, limited laboratory resources, large class sizes, and insufficient administrative support. These challenges became even more pronounced during the pandemic. Table 3 highlights these concerns.

Table 2 Thematic analysis based on the focus group interview with the head teacher participants on the experiences of science teaching during the pandemic (n = 5)

Sample Questions	Initial Coding/ Participants Responses	Code	Subtheme	Theme
How do your teachers teach science subjects or courses in the pandemic time	*HT4: "Printed Self Learning Modules are distributed and retrieved every Monday, but teachers monitor the pupils at least once a week for those pupils with gadget & internet connectivity only by Messanger or Goggle Meet…for those without gadgets it is through the parents when they come to get or return modules to school."*	Limited movement Do printed modules Advised home visitation Printed self-learning modules Through parents Through online	Flexible teaching modalities through modules and online Blended learning	Flexible Learning
When you improvised materials, what are the possible learning outcomes you achieved?	*HT5: "When materials are improvised creativity, resourcefulness, uniqueness, economy, localization & contextualization were achieved".*	Resourcefulness Improvised materials Demonstration teaching Doing performance tasks and group activities Materials from the house	Home-based learning using available materials at home	Contextualization and localization

Table 3 Thematic analysis based on the focus group interview with the teacher participants on the challenges of teaching science (n = 11)

Sample Questions	Initial Coding/Participants Responses	Code	Subtheme	Theme
How do you teach the process skills to your learners?	*T4: "Activities in science made sure that it delivers applications for their daily lives and can maximize their scientific skills".*	Science activities Maximize Science Skills Experimentation and Modules at Home Application in daily life	Science activities Laboratory Activities at Home	Experimentation
What are the challenging yet meaningful and engaging activities you usually give to your pupils?	*T11: "I provide them activities that are easy and with that materials can be found around them, yet these activities are still hard for them".*	Limited resources Hard to understand lessons Cannot comprehend activities	Unavailability of raw materials Low comprehension	Challenges in science engagement and comprehension

The findings indicate that teachers in last-mile schools face significant challenges in engaging students with science due to limited resources, low comprehension, and difficulties in applying scientific concepts. The lack of laboratory facilities and raw materials limits opportunities for hands-on experimentation, making it difficult for students to develop essential process skills.

The pandemic further exacerbated these issues, as remote learning prevented teachers from effectively monitoring student progress. Without access to proper laboratory setups, students struggled to grasp scientific principles, leading to gaps in understanding. Teachers attempted to address these challenges by incorporating household materials and contextualized learning strategies, but these methods had varying degrees of success.

Research supports the importance of laboratory activities in enhancing scientific comprehension. Fayomi (2017) found that practical experiments, when designed as real-world problems, significantly improve students' problem-solving abilities. However, the absence of structured guidance and appropriate resources in last-mile schools limits the effectiveness of such activities.

Additionally, science educators must possess both theoretical and practical knowledge to ensure high-quality instruction. An effective science curriculum requires not only content mastery but also pedagogical strategies that enhance student engagement. Otsetov (2020), further emphasizes the role of science teachers in fostering a strong science culture within schools, advocating for continued professional development and collaboration with peers.

The pandemic posed additional obstacles for teachers, particularly in refining students' laboratory skills, as they could not directly observe hands-on work. This issue was further compounded by the lack of devices in last-mile schools, making it difficult for teachers to monitor students' progress effectively. Laboratory activities, however, have been shown to be particularly beneficial for students who scored in the middle to low range on pretest achievement indicators. Fayomi (2017), highlighted that laboratory teaching improved students' problem-solving abilities in physical chemistry, especially when experiments were structured as real-world problems without explicit instructions.

Teachers encouraged the use of available household materials for experiments, ensuring that activities supported basic skill development. However, the absence of proper monitoring led to gaps in students' understanding of scientific concepts. In last-mile schools, additional constraints such as limited internet connectivity and restricted access to digital devices further hindered science instruction.

To improve science instruction in last-mile schools, there is a critical need for increased resource allocation, teacher training, and administrative support. Addressing issues such as low comprehension, lack of laboratory facilities, and limited access to instructional materials will be essential in enhancing science engagement and comprehension among students.

Meanwhile, Table 4 shows the thematic analysis from the focus group interview with the head-teacher participants on the challenges of teaching science in the last-mile schools.

The table clearly shows that teaching in the last-mile schools poses a lot of problems. The head-teachers monitors' teachers both formally and informally, and the pandemic's spread exacerbates the issue, especially for those who teach multi-grade classes.

Head teachers observe it difficult to deliver lessons because of the limited resources that teachers can utilize to fulfill the objectives of the day. There was also a scarcity of available activities, especially experimentation. They also observed that pupils struggle in constructing or creating projects or performance outputs especially when it is done at their house with less teachers' supervision.

Head teachers identified the biggest challenge as teachers' lack of science training, with many teaching outside their specializations. Teachers struggled with basic skills, laboratory apparatus use, and up-to-date teaching methods. Despite these weaknesses, they made their best efforts. Harris and Hodges (2018) observed comparable difficulties in rural schools. Potential teachers may be turned off by remoteness for other reasons besides only being far from resources that are more readily available in cities or suburbs. Additionally, there is a subconscious notion of remoteness that affects how a rural community is perceived both internally and externally.

Head teachers emphasized the need to develop process skills in both teachers and students. Modular teaching limited observations of whether pupils acquired these essential skills. Laboratory skills motivate students and enhance understanding, but many rural schools lack resources and qualified science teachers. Teachers must be trained to use laboratory materials effectively.

Identification of the Ways to Address the Challenges of Teaching Science in the Last-Mile Schools

Collaboration is a primary need for the success of the teaching-learning process, especially at this time of the pandemic. The community is the basic partner of the school in transferring lessons to the learners.

Table 4 Thematic analysis from the focus group interview with the head teacher participants on the challenges of teaching science (n = 5)

Sample Questions	Initial Coding/Participants Responses	Code	Subtheme	Theme
What is the relevance of the science curriculum in the multi-grade class?	*H1: "Learners are always on the lookout for fresh information. They like participating in things that are novel to them. However, some individuals were unable to meet the demands of the activities despite the availability of knowledge and abilities because of a weak educational foundation".* *HT5:" Teachers cannot conduct experiments properly because they cannot guide the pupils properly as they do not know the basic skills to provide the pupils".*	Lack of gadgets and apparatuses Performance level of pupils Limited access to resources Pupils understanding is low Scarcity of application and experimentation activities Appropriate teaching strategy Projects and performance outputs Lack of teachers' training	Difficulties of delivering lessons Problems encountered	Problems in Teaching and Learning Science
What are the teacher's considerations as to the learning environment when they construct lesson logs?	*H3: "We use the MELCS in the science curriculum. It is believed to be crafted and geared toward the development of learners' basic scientific processes and skills."*	MELCS Modular Learning Process skills Competencies for learners to acquire	Various teaching strategies and process skills	Process Skills
Can the teachers collect properly the data from the performance of the pupils?	*H2: "Traditionally, we do the formative and summative examination for our learners at the same time. Performance task is also being given for them to apply what they have learned."*	Examination Test in modules Performance Tas Written-test Performance test Summative assessment Individual or group activities Quizzes Low Scores	Assessment activities in various forms	Assessment Strategies

The contribution of the community was also highlighted. The presence of the local government, elders in the community, the family, and parents should be maximized, hence teachers should learn more about proper collaboration to produce quality learners and maximize the scientific learning environment.

Community collaboration plays an integral part also in the teaching and learning process now that it is a pandemic, so the presence of the people of the community should be considered. Trained teachers should also train these people on how to help the learners that are in their community, especially in the delivery of science lessons and activities.

Community linkages are very essential in carrying out a lesson even before the pandemic. In small barrios, the family members, and elders (*panglakayen)* assist the teachers, especially in the immediate needs of the school.

Table 5, discussed the thematic analysis from the focus group interview of the teacher participants on the ways to address the challenges of teaching science.

Teachers said that parent and community involvement play a vital role in achieving the goals of science. The parents who became their teachers in the meantime are valuable helpers of the teachers and the learners. Their contribution in providing community-based lessons and materials helped in the realization of the objectives of the lessons.

The available resources and alternative resources in the community and the help of the people are big contributions to the learning process. The link between the school and its community is already considered essential considering the very remote situation of the schools from the town/province's capital. There is a collaborative working relationship between two stakeholders, especially in times of special activities and unforeseen circumstances.

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The community plays an integral role in building the learners. The involvement of the community is needed for the objectives of the lessons to be carried out. Therefore, teachers should include the community people, the parents, and the elders in training and in doing capacity-building activities for them to be able to acquire basic knowledge, process skills, become lifelong learners, and be effective partners in science teaching.

On the other hand, the head teachers agreed on the help of the community to address the identified challenges of the last-mile schools. They also added that a need for teachers' training workshops should be prioritized.

Table 6 shows the thematic analysis based on the focus group interview of the head teacher participants on the ways to address the challenges of teaching science.

The head teachers also expressed that the teachers need training for faculty development to help their teachers acquire necessary scientific skills and knowledge. They said that these trainings such as the use of laboratory facilities and equipment and process skills will help the teachers develop engagement towards teaching science to the learners.

Table 5 Thematic analysis based on the focus group interview with the teacher participants on the ways to address the challenges of teaching science (n = 11)

Sample Questions	Initial Coding/Participants Responses	Code	Subtheme	Theme
What assistance do you give to your pupils when they need teachers during experiments and lectures?	T2: *"I coordinated properly with all barangay officials and was in close contact with them always… explained their roles and solicited their support."*	Available resources and alternatives in the community Hand-in-hand collaboration Monitor through parents and guardians	Parent and community involvement in monitoring activities	Community Collaboration

Table 6 Thematic analysis based on the focus group interview with the head-teacher participants on the ways to address the challenges of teaching science (n = 5)

Sample Questions	Initial Coding/Participants Responses	Code	Subtheme	Theme
What do you think are the needs of your school in science in terms of: A. Teaching materials/ Laboratory Facility B. Faculty Development	HT2: "*Teachers need more training in teaching Science effectively most especially this time of distance learning. Teachers struggle on how to fully assist their learners having the printed modular learning."*	Faculty development training ICT integration and virtual teaching Training for Science class and laboratory use Distance learning	Trainings and workshop for faculty on ICT and teaching Science	Training Workshop
How do you establish link to the community in the delivery of the science lesson during a pandemic?	*HT5: "The link between the school and its community is already considered essential considering the very remote situation of the school from town/province's capital. There is a hand-in-hand working relationship between two stakeholders, especially in times of special activities and unforeseen circumstances"*	Communicate through messenger Establish trust and a clear line of communication with the community	Connection with the community on school management	Community involvement and collaboration

Training is required because a science teacher teaches and guides students in investigating and comprehending key scientific concepts, such as how to solve problems and obtain evidence to back up claims or decisions.

For educational excellence, ongoing teacher training is crucial for one simple reason: in order for teachers to remain at the top of their game, they must be provided with frequent chances for professional development. If they do not keep pushing for greatness, even the most talented educators will start to fall behind.

Mahmud et al. (2018) said that the training should focus development of science teacher education closely related to the development of the national education system.

The common themes of teachers and head teachers was community collaboration and community involvement. This only proves that science teaching should not be limited to the classroom but should be extended within the community. The assistance of the community is very important to attain the scientific objectives of daily lessons.

Conclusions

This study highlights the persistent challenges of last-mile schools in Ilocos Norte in delivering science education during the pandemic, including resource scarcity, teacher shortages, and geographic isolation. Despite these barriers, educators exhibited resilience through flexible learning, community collaboration, and creative resource use. The findings align with the Pakasaritaan Theory, reinforcing the role of localized, community-driven approaches in addressing educational disparities and offering insights for its refinement in science education.

Compared to other studies on last-mile education, this research confirms common challenges but also showcases unique adaptive strategies shaped by the Ilocano context. Additionally, it raises critical questions about the effectiveness of SDG 4.7 and the Last Mile School Program in achieving inclusive, quality education. Moving forward, policy recommendations should prioritize sustained teacher training,

infrastructure investment, and culturally relevant pedagogies. Future research should explore student learning outcomes, long-term policy impacts, and alternative teaching models to strengthen science education in last-mile schools.

To improve science education in last-mile schools, this study recommends strengthening teacher training in inquiry-based learning and ICT integration, establishing low-cost science laboratories, and enhancing community partnerships to improve resource accessibility. Policymakers should expand initiatives like the Last Mile School Program to sustain improvements in teacher capacity, infrastructure, and digital learning access. Future research should assess community-based interventions, alternative teaching strategies, and technology-enhanced learning models to bridge educational gaps in rural settings.

Recommendations

To enhance science education in last-mile schools, it is recommended that efforts focus on sustained teacher training, improved infrastructure, and the use of culturally relevant pedagogies that connect scientific concepts to local knowledge and practices. Investments in facilities, learning materials, and digital access are essential to create supportive learning environments, while community and stakeholder engagement can reinforce the relevance of science in everyday life. Future research should investigate the impact of these practices on student learning outcomes, assess the long-term effects of policy interventions, and explore innovative, context-sensitive teaching models that can be scaled and sustained in underserved areas.

Conflict of Interest

The authors used ChatGPT to assist in language polishing. The authors confirm that the use of AI does not compromise the integrity and validity of the result and its content.

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