

Exploring Science Education in Last-Mile Schools: Experiences and Challenges

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Abstract

This study examines the experiences and challenges faced by science educators in last-mile schools in Ilocos Norte, Philippines, particularly during the pandemic. Employing a participatory qualitative action research method rooted in the pakasaritaan theory, the research highlights the unique cultural and contextual factors influencing science education. The study reveals that despite high scientific literacy, students struggle with retention, reasoning, and real-life problem-solving skills. The Department of Education's Last Mile School program aims to address these issues by improving facilities and faculty capabilities. The findings underscore the need for localized, culturally sensitive teaching strategies and the integration of sustainable development goals (SDGs) into the curriculum to enhance science education outcomes.

Keywords: Lastmile, Science, Education.

INTRODUCTION

There are several areas of concern regarding the services offered to pupils in Science classes for their part, devised a curriculum in Science that focuses on the influence of policy and cultural context for diverse learners. While primary schools have been tested on the teaching of Science and learning of students, it has been indicated that students' scientific literacy is high.

Science as a subject has its different strategies for learning to be assimilated, one effective way of learning Science is the laboratory method in which materials should be manipulative inside the laboratory room. This method of teaching Science is still effective and efficient these days to strengthen meaningful learning in Science.

Science teaching in the Philippines follows the Department of Education's pedagogical process imposed through the K to 12 Curriculum. Science starts in Grade 3 until Grade 6 in elementary. Science in the country is alarming as the Program for International Student Assessment (PISA) result showed that the Philippines is ranked 353rd in Science (OECD, 2019). Studies revealed that Filipino students have low retention of concepts, limited reasoning and analytical skills, and poor communication skills. Many Grade 6 and fourth-year students find it hard to relate lessons in real-life problem-solving situations and that they cannot even solve a simple problem (Department of Science and Technology & University of the Philippines - National Institute for Science and Mathematics Education Development, 2011).

Learning is a complex process where student motivation, teacher competence, learning material, and several other aspects interact with each other. The traditional classroom setting has gradually changed into a virtual environment. The technical revolution has dramatically changed the learning process, at the same time it has brought about different opportunities to learn.

The Department of Education has launched its Last Mile School program, last-mile schools are schools with multi-grade classes and a population of fewer than 100 learners with Indigenous Peoples (IP). The Last Mile Program has a two-year program that concentrates on 2020 and 2021. Facilities and infrastructure are the main focus of the program and after one year, they will have faculty enhancement. DepEd's Memorandum No.59, s. 2019, enjoined all other government agencies to help them in the capacity building of the teachers, provision for laboratories and equipment, and internet connectivity.

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Science in Education for Sustainable Development (ESD) is a critical component of the Sustainable Development Goals (SDGs). Its objectives include one of the Sustainable Development Goals on education (SDG 4.7), and it is often regarded as a catalyst for the accomplishment of all 17 SDGs.

Education is a fundamental human right and a catalyst for long-term growth and peace. Each objective in the 2030 Agenda for Sustainable Development needs the education to equip individuals with the information, skills, and values necessary to live in dignity, develop their lives, and contribute to their communities (*Leading SDG 4 - Education 2030*, 2020).

ESD equips everyone to make educated choices that promote environmental stewardship, economic viability, and a fair society for current and future generations. It seeks to provide students with the information, skills, attitudes, and values required to meet the problems of sustainable development.

This resource bank was created in conjunction with the UNESCO guideline paper Education for Sustainable Development Goals - Learning Objectives. It is intended for educators, education planners, and practitioners. It includes hundreds of pedagogical concepts for classroom activities and multimedia tools for integrating ESD into teaching and learning at all levels, from early childhood care through secondary school.

Education is at the heart of this SDG, which seeks to provide universal access to school, beginning with primary education. Specifically, the objectives include expanding opportunities for youth and adults to receive technical and vocational training to obtain better jobs; eliminating disparities in educational opportunities between men and women; providing the appropriate education for children with disabilities, indigenous people, and conflict victims; and improving school facilities to ensure a safe and positive learning environment for all students.

Sustainable development is the greatest problem mankind has in the twenty-first century. Global economic growth has certainly accelerated in recent years in several nations. The sustainable economy is defined by a paradigm shift away from fossil fuel-based economies and toward biological economies, which are motivated by the ideals of sustainability, resource efficiency, and "circular economy." Because the sustainable economy is built on the effective use of biological resources and social changes, it has enormous potential for achieving the United Nations' Sustainable Development Goals (Mishra, 2021).

On the other hand, stakeholders should be included to attain sustainable and inclusive goals and gain development strategies for the country. It is necessary to include them because their initiative will gain the power to succeed (Philippine Statistics Authority, 2019).

The Philippine Statistics Authority acknowledges quality education by institutionalizing the Alternative Learning System. It is a collaborative effort of the Department of Education and private sectors to reach out to the "last miles" particularly the youth sector and other vulnerable groups to receive quality education (Philippine Statistics Authority, 2019).

The goal of the program is centered on "leaving no one behind." Data is imperative in this respect to measure the extent of the country in leaving no one behind. Another program of the country is the collaboration of government and non-government sectors that will help to empower people and ensure inclusiveness and equality. The country's program on SDG will ensure activities and projects are localized. This project used the whole-of-society approach that requires human and financial resources from the government, private sector, and non-government sectors. This project will lead to the Philippine AmBisyon. (Philippine Statistics Authority, 2019).

Through a critical textual analysis of the content and structure of the new Australian Science curriculum, Rodriquez (2016) identified a national Science curriculum. In the context of the Australian Science curriculum, it was identified that the curriculum does not center on the cultivation of nature and species rather it is concentrated on the giving of anthropocentric attitudes towards the environment.

The review of Davis, et al. (2016) mentioned that it is hard to understand the curriculum materials. He addressed this gap by making a mechanism for teacher curricular decision-making, this mechanism helps the

teacher to improve in their teaching, teachers target more support for Science, and instructional materials are used as intended.

In this same article, Marlow Ediger describes elements he feels are conducive to developing an effective science curriculum. These include: (1) inquiry learning; (2) reflection; (3) experimentation; and (4) technology. Also offered here are guidelines for students working in small groups: (1) respect the thinking of contributions made; (2) clarify ideas not understood; (3) have all participate, if possible; (4) stay on the topic being pursued; do not stray to the irrelevant; and (5) no one should dominate the discussion.

Analysis of documents on the influence of Science education in Israel shows that international surveys and standards should be used in teaching. (Klieger, 2015)

Lowe (2015) implemented the new Science curriculum and examines the support and preparation for implementation. This study revealed that in two schools a problem occurred in the comprehension of teachers on the curriculum documents and content expectations. The study reveals the implication of implementing curriculum reforms.

Having such a problem, students' diversity of learning will be addressed if the purpose of Science education is congruent to the purpose of education.

Science education stands at the intersection of societal progress, technological innovation, and environmental stewardship. Its role in shaping informed citizens and driving sustainable development is paramount, yet challenges persist in ensuring equitable access and fostering meaningful learning experiences. This comprehensive review delves deeper into the key advances, critical issues, and emerging trends in science education globally, elucidating the multifaceted landscape of pedagogy, curriculum design, and educational policy.

RESEARCH DESIGN AND METHOD

The research used a participatory qualitative action research method incorporating the *pakasariitaan* theory of Dr. Agcaoili was the process of localizing the practices and strategies in Science teaching and learning.

Exploring the PAR as a method of inquiry incorporates the Theory of *Pakasariitaan* by Dr. Agcaoili which provided an overview of the process to present the study. The indigenous Ilokano word *pakasariitaan* (paka + sarita + an) contextualizes and frames this study to produce the body of knowledge from the stories of the people and immersion with the people. In putting together the *sarita* (stories) of the participants uncovered the context of their experiences and a certain tradition of teaching and learning Science concepts has been revealed.

The theory validates stories and experiences that open the possibility of intervention in the process of model formation. Also, the *pakasariitaan* provided a brief theoretical and methodological overview of critical ethnography (CE) to establish its link to what is the norm in the process of learning and teaching in the last mile schools. And, the *pakasariitaan* provided a detailed discussion of how science laboratory teaching and learning are utilized.

On the other hand, this theory contributes to research methodologies by developing culturally appropriate protocols that respect and celebrate the stories of marginalized groups to work toward linguistic pluralism and social justice (Soria, 2012).

Hence, PAR as a method of research has been enriched through the localization and "localization" of the practices through engaging and digging within the *pakasariitaan* of the people. These stories and the history of the last mile school science teachers and administrators determined the factors that contributed to the created model. The utilization of *Pakasariitaan* as a springboard in using PAR is a unique contribution to research.

The rural elementary schools of Ilocos Norte were the site of the project, wherein five (5) rural schools of the Division of Ilocos Norte were identified based on the submitted report on the Last-Mile School of the Department of Education. These 5 identified schools are situated in Sarrat, Vintar, Pasuquin, and Bangui all

in the province of Ilocos Norte. The schools were Danao Elementary School, Alsem Elementary School, Madalayap Elementary School, Paddagan Elementary School and San Andres Elementary School.

These schools offer multi-grade classes and have a low population with two to five teachers in the field. Most of their pupils are walking to school however in 2021, due to the slaughter of the pandemic, other modalities have been utilized, as in the case of these schools' modular instruction was used. Hence, teachers gave the modules to the Barangay Officials to distribute to the pupils and retrieved them from the officials which they will send back to the schools for checking.

The participants of this study were the last-mile schools of Ilocos Norte. It included the science teachers and school administrators from the five last-miles schools.

Purposive sampling was used to identify and select the participants. This sampling technique was used to recruit participants that can provide in-depth and detailed information about the last-mile schools in terms of science teaching and learning.

The teachers and school heads in the main study were selected, through a process of elimination, according to certain criteria location of the school to the town proper, student population, and several science teachers available. From the list of schools provided by the Department of Education Division of Ilocos Norte, only five were qualified to be included in the gathering of data hence, these schools are located near the town proper, the pupils' population is high and the teachers were available during the conduct of the study. The participants also have time and interest during the duration of the data gathering. Also, these eleven teachers and five school heads from five separate schools indicated their willingness to participate.

On the other hand, excluded were the other last-mile schools in Ilocos Norte listed by DepEd due to the distance of the school from the town proper and the limited number of science teachers in the school, these science teachers are likewise not available due to other activities and due to the COVID-19 pandemic during the duration of data gathering. They likewise did not show their willingness to submit themselves for the study as they did not reply in the electronic mails sent to them.

The sample size helped in the deep analysis and systematic investigation of the science teaching and learning during the pandemic and the challenges of the last mile community in teaching science and how the last-mile schools coped up with the challenges. The teachers and the school heads provided relevant information regarding their experiences. These participants were also the source of data for the construction of the model, they were also the internal validators of the model.

By participating in this research, the participants benefit others by helping people to better understand the experiences of Science teachers in the last-mile schools. Several steps were taken to protect the anonymity and identity of the participants.

The semi-structured interview questionnaire used for gathering the data in the last mile schools was validated by experts through the use of an adapted rubric (see Appendix G). In this study, content validity was chosen to validate the semi-structured interview questionnaire. The purpose was to determine whether the questions covered the content of the research questions that it was supposed to measure.

Experts served as validators of the semi-structured interview questionnaire. These are five (5) experts who are familiar with the topics as they are immersed in science teaching. they are teachers and school administrators for more than 15 years from the State Universities and Colleges and are Doctorate Degree holder. They are also experts in question construction for qualitative questionnaires. The validation determined the number of questions that can be answered by the research questions. The validators used a rubric in validating the semi-structured questionnaire.

The semi-structured interview questionnaire does not contain any mention of the participants' names or any identifying information from the interview.

RESULTS AND DISCUSSION

Key Advances

Policy and Cultural Context in Science Education

The integration of policy and cultural context into science curricula represents a pivotal advancement in educational theory and practice. Recognizing the influence of socio-cultural factors on learning outcomes, initiatives like those by Bergamin et al. (2016) emphasize the need for inclusive educational practices tailored to diverse learners. By aligning curricular objectives with broader societal goals, policymakers can ensure that science education remains relevant and accessible to all.

Technology Integration and Virtual Learning

The proliferation of technology has revolutionized traditional learning paradigms, ushering in an era of virtual classrooms and digital resources. Initiatives such as the Last Mile School program in the Philippines exemplify efforts to bridge the digital divide and enhance educational access (DepEd Memorandum No. 59, s. 2019). While virtual learning presents unprecedented opportunities for global collaboration and resource sharing, challenges persist in ensuring equitable access and mitigating disparities in technological infrastructure.

Science Education for Sustainable Development (ESD)

Aligned with the Sustainable Development Goals (SDGs), science education serves as a catalyst for fostering environmental stewardship and societal well-being (Leading SDG 4 - Education 2030, 2020). By integrating ESD principles into curricula, educators empower learners to address complex global challenges and cultivate a sense of environmental responsibility. Initiatives such as UNESCO's Education for Sustainable Development Goals guideline paper underscore the importance of integrating sustainability concepts across all levels of education, from early childhood to secondary school.

Curriculum Design and Pedagogical Innovations

Pedagogical innovations, such as inquiry-based learning and the integration of robotics applications, are transforming traditional teaching methodologies (Marlow Ediger, 2016; Hodges et al., 2016). By fostering student-centered approaches and experiential learning opportunities, educators can enhance student engagement and promote deeper conceptual understanding. However, challenges persist in ensuring equitable access to resources and professional development opportunities for educators.

Addressing Equity and Inclusion

Disparities in educational access remain a significant barrier to achieving inclusive and equitable science education. Initiatives such as the Alternative Learning System in the Philippines aim to promote inclusivity and provide quality education to marginalized communities (Philippine Statistics Authority, 2019). By addressing systemic barriers and leveraging community partnerships, policymakers and educators can work towards ensuring that no one is left behind in the pursuit of scientific literacy.

Global Perspectives on Science Education

Insights from international studies offer valuable lessons and perspectives on best practices and challenges in science education across diverse contexts (Klieger, 2015; Lowe, 2015). By fostering cross-cultural dialogue and collaboration, educators can gain valuable insights into effective teaching strategies and curriculum design principles. However, contextual factors must be carefully considered to ensure the relevance and applicability of educational interventions in different cultural settings.

Emerging Trends

Data-Driven Decision Making

The integration of data analytics and evidence-based practices is increasingly shaping educational policy and practice. By leveraging data to inform curriculum design, resource allocation, and instructional strategies, educators can optimize learning outcomes and address individual student needs more effectively.

Interdisciplinary Approaches

The blurring of disciplinary boundaries is fostering greater collaboration across STEM fields and promoting interdisciplinary approaches to teaching and learning. By integrating concepts from multiple disciplines, educators can provide students with a more holistic understanding of complex scientific phenomena and foster creativity and innovation.

Experiential Learning and Citizen Science

Experiential learning opportunities, such as citizen science projects, are gaining traction as effective means of engaging students in authentic scientific inquiry. By involving students in real-world research projects, educators can foster a deeper appreciation for the scientific process and empower students to contribute meaningfully to scientific knowledge.

Global Citizenship Education

As the world becomes increasingly interconnected, there is a growing emphasis on global citizenship education in science curricula. By integrating global perspectives, multiculturalism, and social justice themes into science education, educators can prepare students to navigate complex global challenges and contribute positively to a more sustainable and equitable world.

By examining key advances and emerging trends in science education, the review offers valuable insights into the experiences and challenges faced by last-mile schools in delivering quality science education. It addresses the unique circumstances and constraints often encountered in remote and underserved communities, shedding light on strategies for overcoming barriers to educational access and quality.

Moreover, the discussion emphasizes the importance of contextually relevant pedagogical approaches, data-driven decision-making, interdisciplinary collaboration, and global citizenship education in addressing the specific needs and challenges of last-mile schools. These insights can inform efforts to improve science education outcomes and promote equitable access to quality education in remote and marginalized communities.

DISCUSSION

While a rural school may seem physically isolated, it may be an excellent location for scientific education. Hence, the need to further investigate the narratives of the last-mile schools. Below are the observed situations on the experiences of the last-mile schools in Ilocos Norte.

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 has been difficult throughout the pandemic—and scientific teaching is no exception. Despite rapidly changing learning settings, STEM educators are rising to the occasion and assisting children through times of uncertainty (Lauren J. Young, n.d.).

According to a recent study presented at the annual American Educational Research Association conference, students are failing to learn science during the pandemic, even though they find it more fascinating and relevant to their life (Sparks, 2021).

While increasing students' scientific literacy is a crucial aim of K-12 education, the precise definition of that term is debatable. The pandemic presents a once-in-a-generation opportunity for parents, school board members, PTA members, and legislators to examine whether government and national science education standards and local curricula contain the scientific literacy that today's students need (Morris et al., 2019).

The interview with the participants provided a strong background of their experiences in teaching science, especially during the pandemic. Table 1 showcased the thematic analysis from the focus group interview of the teacher participants when asked specific questions about their experiences in teaching science during the pandemic.

Table 1: Thematic Analysis from the Focus Group Interview of the Teacher Participants on the Experiences of Science Teaching during the Pandemic (n=11)

Sample Questions	Initial Responses	Coding/Participants	Code	Subtheme	Theme
How do you facilitate laboratory classes?	T11: "By using the messenger app through video calls I have to meet my class in able for them to understand the concepts they need to know and develop."		.	Online Modality	Flexible Learning
How do you conduct lecture classes?			Laboratory experiences at home	Available community resources	
What are the teaching materials and equipment that you have in the classroom that you use in science teaching?			Lecture class through a video call . Learning by doing . Used materials available in the community		
Based on your experiences how do you assess your pupils as to their understanding of Science?	T8: "Based on my experience they are hard up in coping with the subject. Other lessons are too high 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 able 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 teachers' responses to their experiences in teaching and learning were evident that the teachers are doing their best to meet the objectives of the lessons for them to provide the best learning experiences. In teaching experiences, teachers used laboratory materials to discuss lessons online. Teachers used online platforms to manage the class and observe activities or experiments they provide to the learners. However, internet connection is still a problem, therefore, they do not discuss lessons with the pupils always.

During the pandemic, the teachers also showed their best in delivering the lessons. They were challenged by the pandemic because materials like laboratory apparatuses are not present in their houses. They also consider the help of the parents to help deliver the lessons. They distribute it to their learners and make sure that activities are easy to cope with. For hard activities, teachers meet their classes online.

According to one teacher, their method of teaching and learning is modular; they just monitor students through phone calls and group chats. They believe this is unfair to certain students who lack devices and internet access.

Various online modalities utilizing the available community materials were the mode of teaching in the last-mile schools they utilized these modalities in lecturing and even in experimentation. This mode of delivery of lessons agrees with the final theme which is flexible learning. Flexible learning has been the most used modality during difficult times.

Flexible learning according to Dr. Greg Pawilen (2022), is a learner-centered approach where students can choose the pace, place, and mode of delivery of their lessons. This description has been utilized in the last-mile schools where teachers only distribute modules and pupils will learn at their own pace.

With this mode, pupils find it difficult to learn especially during experiments and activities since parents cannot discuss the basic concepts in the lessons. It was also implied that learners are having difficulty learning about the subject. Pupils are average but have difficulty understanding the lesson well. It was very evident through the teachers' presented pupils' scores in activities. These different observations by the teachers posted problems, issues, and concerns in teaching science which embodies the other theme.

Even with the presence of various problems teachers still find ways to teach their learners the concepts of science as prescribed by the curriculum. Home-based learning utilizing localized materials found in their environment was used. This method is helpful based on Chillag (2020), who said that the use of localized instructional materials results in the high performance of learners, significance of lesson to learners' daily living, lesson content and activities are gathered from the school and community, therefore, easily understood, improve skills and creativity and as an innovation, it allows to meet the learning needs and could also lead to career growth and development.

Therefore, flexible learning, problems, issued and concerns in teaching science and localization and contextualization were the main themes of the teachers' response. The experiences of the teachers in teaching and learning science during the pandemic posed a challenge to them. These experiences were also experienced by their school heads as they have identified various similar experiences with science teaching and learning during the pandemic.

Table 2, was the thematic analysis from the focus group interview of the school heads.

Table 2: Thematic Analysis from the Focus Group Interview of 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 teacher 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 Messenger or Goggle Meet...for those without gadget are 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	Home-based learning using available materials at home	Contextualization and localization
What can you say about the teachers' science class simulation?		Doing performance tasks and group activities Materials from the house		

School head also has their share of observations on the teaching and learning experiences in science which they shared during the interview. They have common observations with the teachers on the teaching of science. Many problems were raised during the pandemic such as monitoring their teachers. There were limited movements therefore teaching is only through modules and sometimes online for those who have gadgets. Parents were also included in the teaching process as they were of help in the monitoring of their learners.

The online and modular modes of teaching were evident avenues to discuss the expected lessons from the MELCS. Head teachers were able to observe their teachers on the various modalities they utilized during the pandemic. They said that teachers are doing their best to embrace the new mode of teaching.

As regards to the materials in teaching science when these materials are available, the learners explore and discover, hence, they learn best by doing. Head teachers observed that the teacher is the classroom facilitator that assists and reminds the pupils of the safety precautions needed to observe. The major issue occurs when COVID-19 spreads across the globe; during the period of the pandemic, teachers disseminate and retrieve self-learning modules every week. Teachers supervise students who have gadgets at least once a week through messenger and Google Meet. Since monitoring time is restricted, hands-on activities become constrained as well. Home visitation was also advised since the location of the school to the houses of the learners were nearby.

The experiences of the head teachers coincide with the experiences of the teachers on the flexible learning modality that has been utilized during the pandemic. However, the flexible learning mode became a problem due to the informal monitoring of school heads on the delivery of lessons.

During the flexible delivery of lessons, contextualization and localization of available materials have been evident in the teaching-learning process. Improvisation also played a big part in the learning process however materials were insufficient due to their distance within the town proper. Improvisation develops creativity and resourcefulness among the learners. Pupils and teachers utilized the available materials they can see around them just to meet the objectives of their daily lessons.

In the learning process, they found out that materials in teaching played an especially important role in the learning process. It develops skills when good materials are presented. Self-learning modules were used to learn hence minimum target lessons were only realized.

These experiences of the teachers and school heads were springboards to review the situation of the last-mile schools in teaching and learning during the pandemic. The themes that emerged from the participant's responses were able to unite a common issue in the teaching and learning process. Adaptation of flexible learning helped a lot in the last mile schools and the creativity and resourcefulness of both the teachers and learners through the utilization of the contextualized and localized materials provided a big help in the teaching and learning of science. On the other hand, there were problems, issues, and concerns that have been observed especially on the part of the teachers.

The experiences in the visitation of the last-mile schools agreed with Smith (2020), in the conduct of a proof-of-concept analysis in which he found out that last-mile schools have historically struggled with educational access. It is evidently becoming more struggling due to the presence of the pandemic. This, therefore, signifies that a vast opportunity through the learning and teaching process should be provided in these parts of the community.

The experiences of the participants in the last-mile schools teaching science posted challenges to the teachers and the school heads.

Explanation Of The Challenges Of Last-Mile School Teachers And School Heads In Teaching Science

Remoteness can deter potential teachers not only on the basis of distance from resources more common in the suburbs or cities but there also is a subconscious concept of remoteness that shapes the perception of a rural community both internally and externally (Harris & Hodges, 2018)).

There are numerous obstacles to science instruction in Philippine schools, including the scarcity of trained science teachers, a dearth of high-quality texts, insufficient equipment, huge classes, and a lack of administrative support, to name a few.

An effective science classroom was characterized as one in which students had opportunities to physically interact with instructional materials and engage in varied kinds of activities. The laboratory approach appeared to be more useful in those situations where high levels of thought, learning experiences, and outcomes demands were placed upon subjects (Simon, 2014).

When the researcher visited the schools, the teachers showed their classrooms where laboratory apparatuses were hidden. It is sad to note that these materials were still in their plastic wrappers and teachers do not know how to properly handle them. Hence, they do not utilize these apparatuses. These apparatuses were given to them by the government before the pandemic.

The problems became more evident due to the pandemic. Table 3, provide the thematic analysis from the focus group interview of the teacher participants on the challenges of teaching science in the last-mile schools.

Table 3: Thematic Analysis from the Focus Group Interview of the Teacher Participants on the Challenges of Teaching Science (n=11)

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

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

On the other hand, laboratory skills are particularly important in science learning because they motivate students to process the ideas they learn. In a study about science education in 19 countries, in six countries where 10-year-old students made observations and did experiments in their schools, the level of achievement in science was higher than in schools where students did not perform these activities (Hofstein, 2017).

Laboratory skills should be one of the basic skills that a science learner should learn because this embodies their science process skills. The teachers emphasized the use of available materials at home for experiment activities or experiments They also said that they made sure that activities will promote basic home skills. The

teaching of the process skills is evidently the main challenge of the teachers as they are not sure if these process skills are acquired by the learners. Science concepts were not properly established because the teacher cannot monitor properly the process of doing the experiments.

Scientific educators at all levels must continue to investigate the laboratory's function in science education. Also, observation is a critical component of science. It enables teachers to see the outcomes of an experiment, even if they are unexpected. It enables teachers to notice unexpected things around, which may pique interest and inspire new experiments. Accurate observation is even more important than observation.

Teachers said that problems in science activities delivery is the main concern of the last mile schools. Teachers do not know if the activities that has been provided will deliver a maximum science skill and will provide lessons and scientific concepts. With this, the main theme process skill is the major concern in science teaching and learning. Science process skills should be taught well and enhanced well the learners through science activities and experiments that promotes the necessary steps in scientific method. Learners should use process skills to develop essential scientific understanding.

On the other hand, problems in teaching and learning science were raised during the interview. They said that there were readily available materials in the community and tv-based and radio-based materials also helped the learners learn on their own. This can only be possible if the teacher can motivate and guide the learners well in adopting lessons from the materials provided. However, the lack of gadgets and internet connection is a major concern of the last-mile schools. With this, teachers cannot also provide additional learning instruction and discussion to the pupils to enhance the topics in the module. Teachers sort out ways to properly attain their objectives despite not going to school they provided activities that are essential and can be easily done at home. Updates from parents are also some help towards the achievement of the goals of teaching.

Another issue and concern were the types of applications that experiments, and activities provided to the learners. Since they have limited access to resources the performance level of the learners was also at stake. The projects and performance tasks are not enough to provide meaningful and challenging lessons that can give real-life applications.

While teachers often improvise, supplies for fundamental laboratory experiments are given by the government, teachers keep them locked away in cabinets given the lack of talents and skills in handling these items. They thought that manipulating existing resources improved teachers' creativity, resourcefulness, originality, economy, localization, and contextualization, but they lacked the necessary fundamental abilities.

According to research, the most critical element that schools can offer to assist students in succeeding is effective teachers. This is particularly true for schools that are struggling. The science teachers and learners and their learning space place a vital role in the achievement of the goals for science. The participants shared their issues and concerns and the instructional process in teaching science. The teaching and learning process posted concerns and issues on the delivery of lessons to the pupils.

Teachers must possess both theoretical and practical knowledge and skills in the fields of science, learning, and science education. display and foster in their pupils, and the attitudes they transmit intentionally or unintentionally all affect the information, comprehension, skills, and attitudes that students acquire (National Academies of Sciences, Engineering, 2020).

Additionally, a good science teacher contributes to their school's high-quality, standards-based science curriculum and is active in the larger science education discipline. Science education extends beyond the classroom, and an effective Science educator works to keep colleagues informed of the latest systemic teaching methods. By assisting the school as a whole in achieving success (Otsetov, 2020),

To engage students in science content, educators must help students envision themselves as scientists and engineers, rather than passively observing others perform scientific work. It's about exposing them to science in action rather than just reading about it in a textbook (Estipular & Roleda, 2018).

Observing effective scientific teaching is not the same as observing effective English or social studies methods. School heads, on the other hand, often depend on broad indications of effective teaching, such as subject selection, student involvement, and regular assessments for comprehension. While they are important in any setting, they fall short of defining effective science teaching.

Table 4, provides the thematic analysis from the focus group interview of 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' posts 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. On the process of monitoring classrooms during this pandemic: They described the strategy they plan to take and, if necessary, will provide alternatives. During the observation time, they do not obstruct the flow of discussion. They promptly share their observations and suggestions after the session.

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 are hard up in constructing or creating projects or performance outputs if especially when it is done at their house with lesser teachers' supervision.

Table 4: Thematic Analysis from the Focus Group Interview of the Head Teacher Participants on the Challenges of Teaching Science (n=5)

Sample Questions	Initial Responses	Coding/Participants	Code	Subtheme	Theme
What is the relevance of the science curriculum in the multi-grade class?	<i>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".</i> <i>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".</i>		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?	<i>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."</i>		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?	<i>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."</i> 15		Examination Test in modules Performance Task Written-test	Assessment activities in various forms	Assessment Strategies

Performance test
Summative assessment
Individual or group activities
Quizzes
Low Scores

The biggest threat according to the head teachers was the teachers' lack of training. They said that they were graduates of courses that are not concentrated on science, hence, they lack basic skills and knowledge in delivering a more scientific classroom. Utilization of materials for experimentations and laboratory apparatuses was also a common weakness of the teachers they said that they do not know how to manipulate the laboratory apparatuses that were kept in their cabinets as shown during the campus observation. They also said that they were not updated with the activities and applications that they can utilize in making their science teaching effective.

Most of the teachers teach outside of their specializations. There was no teacher that graduated with a science concentration or someone majoring in Science Education in the Master's program. Nevertheless, the head teacher said that the teachers are doing their best in teaching the subject.

This was also observed by Harris and Hodges (2018) who said that the lack availability of well-qualified teachers in rural schools is because of the problem that there are more job opportunities in urban schools. Geographical location and the absence of financial incentives are another burden for teachers.

Remoteness can deter potential teachers not only on the basis of distance from resources more common in the suburbs or cities, but there also is a subconscious concept of remoteness that shapes the perception of a rural community both internally and externally (Harris & Hodges, 2018)).

Head teachers also highlighted the need for the process skills to be developed both for teachers and to learners. The modular delivery of lessons minimized their observations of whether a pupil will be able to acquire the process skills set in the modules. Process skills are very important in science as it serves as the backbone of science teaching and learning.

On the other hand, laboratory skills are particularly important in science learning because they motivate students to process the ideas they learn. In a study about science education in 19 countries, in six countries where 10-year-old students made observations and did experiments in their schools, the level of achievement in science was higher than in schools where students did not perform these activities (Hofstein, 2017).

Laboratory skills are also a lifelong lesson that can be applied in daily life, so students should be able to acquire these laboratory skills to gain a better understanding of what science is and how it works. Acquiring these talents early in their educational careers will lead them and provide them with significant aptitude and abilities that will enable them to combat the events taking place in their environment.

Acquiring laboratory skills should not only focus on the learners but also on the teachers; teachers should have a background in how these materials should be used in the classroom and how these materials and apparatuses are important in acquiring process skills. Improvisation should not deviate from the apparatus's true purpose. When materials are not available, improvisation requires a lot of skills and should adhere to a set of standards so that the material can be used in the way that it is needed.

In the assessment process, before the pandemic, written examinations were given however when a pandemic struck, teachers provided assessments online and in modules. They said that science teaching and learning experiences are developed in the learners by following the prescribed standards set in the curriculum. The objectives of each lesson were met however the application of this concept to real life is still in doubt.

On the performance level of the pupils the schools claim that their pupils are average pupils, they perform well when materials are being prepared. The National Achievement Test ranks these last-mile schools at the average level.

These transcriptions were proven essential based on the documents presented by the participants. The learning plans, matrices, pupils' outputs, and learning materials that have been presented were crafted carefully based on the needs of the learners. The DepEd MELCs were also being followed by the teachers in providing activities for their pupils. Assessment materials were also shown, the material for Grade 3 Science is in the local language, Ilocano, while the other grade levels are in English. The assessment tool is essential and is based on the objectives of the lessons provided during the week or day.

In the observation, documents such as pictures of pupils' output, modules, and test item results were presented. Observations of the physical structure of the school and the laboratory rooms were also done.

It was observed by Harris and Hodges (2018) that rural schools often lack scientific equipment and are unable to provide the same field trips as urban schools. Additionally, science teachers lack access to professional development seminars and conferences, and remote schools have difficulties filling science teaching jobs. The lack of financial assistance for rural areas has an impact on schools and on teachers. The lack of availability of well-qualified teachers in rural schools is because of the problem that there are more job opportunities in urban schools.

The documents that were mined during the school visitation showcased the needed materials for the study, however, saturation has been reached because the documents in all the schools visited were similar because a common document is being given by the division office to utilized by the teachers.

With this, the challenges posed by the teachers and the head teachers provided issues and concerns and recommends a need for upgrading, upskilling, and retooling the basic components and needs of science teachers to provide the maximum needs of the learners. Staying in the last mile is very crucial therefore teachers need to enhance their knowledge and process skills for them to be able to showcase exemplar demonstrations in providing the concepts to the learners.

Identification Of The Ways To Address The Challenges Of Teaching Science In The Last-Mile Schools

Collaboration is a primary need for the fore 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.

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 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.

Table 5: Thematic Analysis from the Focus Group Interview of the Teacher Participants on the Ways to Address the Challenges of Teaching Science (*n=11*)

Sample Questions	Initial Responses	Coding/Participants	Code	Subtheme	Theme
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19	What assistance do you give to your pupils when they need teachers during experiments and lectures?	T2: <i>"I coordinated properly with all barangay officials and was in close contact with them always...explained their roles and solicited their support."</i>	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
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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.

During the pandemic time parents became the partners of the teachers in monitoring their learners, when parents submit modules to the school the teachers ask for their sons'/daughters' status of learning.

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.

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 from the focus group interview of the head teacher participants on the ways to address the challenges of teaching science.

Table 6: Thematic Analysis from the Focus Group Interview of 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: <i>"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."</i>	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 line kish to the community in the delivery of the science lesson during a pandemic?	<i>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".</i>	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
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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.

A science teacher provides instruction and guidance to help students explore and understand important concepts in science, including problem-solving and how to gather evidence to support ideas or decision, hence training is necessary.

The reason why continuing teacher training is so important for educational excellence is simple: teachers need to be given regular training opportunities in order to stay at the top of their game. Even the best teachers will begin to lag behind if they don't continue to strive for excellence.

Mahmud (2018) said that the training should focus development of science teacher education is 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 within the classroom but should be extended within the community. The assistance of the community people is very important to attain the scientific objectives of daily lessons.

CONCLUSION

The study sheds light on the challenges faced by last-mile schools in Ilocos Norte, particularly in the context of teaching science during the pandemic. The remote nature of these schools, compounded by the lack of resources and trained science teachers, has presented significant hurdles. Despite these challenges, there are commendable efforts from both teachers and school heads in adopting flexible learning modalities and utilizing available community resources.

The experiences shared by participants highlight the resilience and creativity of educators in delivering science education under adverse conditions. The reliance on flexible learning, community collaboration, and the use of localized materials showcases adaptability and resourcefulness.

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