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Integration of Language Strategies in Teaching Science

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ABSTRACT

This systematic literature review aimed to examine the integration of language strategies in science education, focusing on their integration in learning materials, teachers' proficiency in integrating them in instruction, and the challenges faced during implementation. Drawing on studies published between 2010 and 2025, this review synthesized findings from empirical and conceptual research mostly within the Philippine context guided by the PRISMA framework. The review identified a variety of language strategies integrated into science learning resources, including vocabulary supports, visual supports, writing and creative expression, and interactive and collaborative activities aimed at supporting scientific literacy and comprehension. Findings indicated that while language strategies significantly enhance students' understanding of scientific concepts, teachers' proficiency in integrating these strategies varies widely due to differences in training, resources, and institutional support. Common challenges such as lack of adequate training, time constraints, resource limitations, alignment issues, and diverse learner needs are consistently reported. The review highlighted the need for sustained teacher education, development of linguistically accessible learning materials, and systemic support to improve language strategy integration in science education. These insights aimed to inform curriculum development, instructional design, and policy formulation to improve science teaching effectiveness and learner outcomes.

INTRODUCTION

Science education is an experience that assists individuals in developing the mental, social, and behavioral skills of a thinker and problem-solver to become a responsible, scientifically and technologically literate citizen of the society. The Revised K-12 education program of the Philippines seeks to improve science education quality by developing scientific literacy among learners (Saro *et al.*, 2024). These efforts have not stopped Filipino students from performing poorly in international science assessments, even in the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA) (Valdez, 2020) and studies have shown that they lack science content, concepts, and process skills (Serrano, 2019). Thus, more localized intervening is needed to aid science learning in the country.

Language is an important component of science learning. Scientific learning involves understanding and using disciplinary-specific vocabulary, academic language register, and complex scientific texts. Therefore, reading, speaking, and writing, with the understanding of how to use specialized scientific language, is critical for learning and applying scientific concepts (Childs & Ryan, 2016). In the Philippines, English is the primary medium of instruction in science, and students with limited language proficiency face greater barriers to learning science subjects (Pandey, 2023). This lack of language expertise is also found in multilingual classrooms. Teachers are faced with different language proficiencies (Pandey, 2023). Thus, when resources are developed for teaching and learning language strategies should be included as a means of supporting the understanding and communication of science (Racca *et al.*, 2016).

Learning Activity Sheets (LAS) in Philippine public schools can be used as a means to assess students' understanding of science concepts and actively involve them in scientific practices and processes. However, the linguistic register and complexity of LAS may either support or inhibit learning science. To consider these linguistic challenges, researchers and educators recommend that language scaffolding strategies such as vocabulary support, graphic organizers, writing assignments, and interactive/collaborative learning experiences be incorporated into the design of LAS and other instructional materials to support development of academic language alongside science learning (Bresser & Fargason, 2023; Becker, 2023). The ability of teachers to successfully mediate the language requirements of these methods is an important factor in their effectiveness (DepEd Schools Division of Ilocos Sur, 2022). Although both DepEd and DOST-SEI have given policy attention to the integration of language strategies, and although teachers and students have received training on the importance of language strategies in science, there is a gap in systematic research into the incorporation of language strategies in science teaching materials and into teachers' knowledge and perspectives regarding the use of language strategies in science instruction in the Philippine elementary school context. To address this, this systematic literature review examines research on language strategies in Philippine elementary school science instruction and provides a

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baseline for further development of science instruction in Philippine elementary schools for the years 2010 to 2025.

LITERATURE REVIEW

The Science education in the Philippine Revised K to 10 Curriculum

The Revised K-10 Curriculum in the Philippines is a new version of the K-12 curriculum. It aims to improve the quality of education by making the material less dense and focusing on competency-based learning. Started in the school year 2024–2025, the curriculum improves the way students learn and teachers teach in core subjects, including Science (Diquito, 2024; Saro *et al.*, 2024). Implementation began in Kindergarten, Grades 1, 4, and 7, with progressive rollout to higher levels, excluding Senior High School for now. This reform responds to issues like curriculum congestion, poor learner performance in assessments, and insufficient teaching time in the prior K-12 system.

Under this reform, science education prioritizes scientific literacy, critical thinking, and problem-solving skills while integrating flexible instructional time (DepEd Order No. 012, s. 2024). The curriculum employs inquiry-based, problem-based, and interdisciplinary learning approaches, promoting students' engagement, scientific attitudes, and decision-making capabilities, which are essential for societal and environmental development. Science starts from Grade 3 to Grade 10, balancing three content standards which are scientific inquiry skills, knowledge application, and attitudes/values, supported by methods like application-led learning and science-technology-society integration. Addressing teacher capacity needs, a flexible time allocation at a minimum of 225 minutes weekly is provided.

The program sees learners as problem solvers, innovators, and stewards of nature through scientific, environmental, technological, and engineering literacy. To spark curiosity, it uses real-world situations and evidence, making science relevant for explanations and decisions on social, health, or environmental issues.

Despite curriculum advances, Filipino students' performance in science remains a national concern, as reflected in international assessments such as TIMSS and PISA (2018 & 2022) where Filipino learners ranked low (Caraig Quimbo, n.d.). Likewise, local studies in Ilocos Norte reveal that students exhibit only moderate proficiency in science concepts and process skills (Serrano, 2019). This gap underscores the need to examine instructional and contextual factors that influence science learning, with language proficiency emerging as a vital variable.

Language and Scientific Literacy in Science Education

Language serves as a strong foundation for science learning, making it possible to communicate specialized terminology, abstract concepts, and ideas, and complex textual structures essential for scientific reasoning and discourse. Scientific literacy demands proficiency in academic language which is different from everyday conversational skills. That is, to facilitate comprehension, critical analysis and synthesis, and effective communication of scientific ideas. This is underscored by studies showing that higher language proficiency correlates directly with improved science performance among students.

Outlined in the Department Order No. 52, s. 1987 on bilingual education policy, Science instruction takes place predominantly in English, serving as the language for curriculum materials, textbooks, and national assessments. This policy positions English as the primary medium to ensure consistency in scientific terminology across diverse linguistic regions. However, persistent language barriers arise when students exhibit limited English proficiency, particularly in rural or multilingual settings. This prompts the teachers to code-switch to Filipino or local mother tongues for conceptual bridging and clarification. While code-switching is facilitative, research highlights that it often reveals inconsistencies between official policy and the realities in the classroom which worsens comprehension gaps for non-native English speakers, including indigenous learners.

Recent changes by DepEd Order No. 010, s. 2024, introduce significant shifts in early-grade language policy, allowing mother tongue use in monolingual classes through translanguaging, bridging, and scaffolding approaches, while stressing Filipino and English as primary mediums from Kindergarten to Grade 3 starting SY 2025-2026. This adjustment departs from the prior Mother Tongue-Based Multilingual Education (MTB-MLE) model, aiming for smoother curriculum transitions amid decongested competencies in the Revised K-10 framework. Consequently, these changes strengthen the need for targeted language strategies integrated in curriculum-aligned learning materials, such as Learning Activity Sheets (LAS), to scaffold students' access to progressively complex scientific content and foster cognitive academic language proficiency (CALP). Pandey (2023) emphasizes that mastering instructional language is key for equitable scientific thinking, especially as materials must now integrate linguistic supports like vocabulary tools and graphic organizers to reduce barriers.

Language Strategies Integrated in Science Learning Materials

High-quality science learning materials serve as foundational instructional resources that must integrate language strategies to address the comprehension challenges posed by the unique linguistic demands of scientific content. These materials bridge the gap between everyday conversational language and the specialized academic language of science, which features dense technical vocabulary, abstract concepts, and complex structures (Tabamo, 2023; Damayanti *et al.*, 2018). In Philippine public elementary schools, Learning Activity Sheets (LAS) is a primary tool for structured self-paced

learning and assessment. Thus, their development demands thoughtful attention to linguistic accessibility, including simplified explanations, contextual examples, and integrated scaffolds to support diverse learner needs (Bansiong, 2019).

Language strategies integrated into science learning materials thoroughly enhance students' access to content, promote engagement in scientific discourse, and cultivate lasting literacy skills essential for inquiry-based learning. These strategies range a variety of multiple modalities to accommodate diverse cognitive and linguistic proficiencies.

• Vocabulary-focused strategies: Keyword identification, sentence frames, and profile building target the acquisition of technical terms, enabling students to build semantic networks and communicate scientific ideas precisely (Abzuldinova & Choydon, 2022; Hoffman, 2013).

• Visual Aids: Graphic organizers such as concept maps, Venn diagrams, flow charts, and character matrices offer visual scaffolds that show relationships and ordering among concepts, especially beneficial for visual-spatial learners struggling with abstract phenomena (Wise & Cooper, 2019; Candidorio, 2010).

• Writing-based strategies: Essays, poems, and learning logs encourage synthesis, argumentation, and reflective expression, promoting critical thinking by requiring students to articulate causal links and evidence-based explanations in scientific contexts (Barbosa *et al.*, 2014; Heiss, 2024; Gregson & Aubuson, 2005).

• Interactive and collaborative strategies: Interactive reading guides, speech choirs, stage plays, human galleries, gamification, and choir reading promote verbal rehearsal, active participation, and peer negotiation of meaning, which transforms passive reading into dynamic understanding of concepts (Tshuma & Nyamupangedengu, 2024; Becker, 2023).

Semantic webs and learning logs demonstrate strategies that help students track conceptual growth and map vocabulary relationships, directly closing the gap between social language and school science discourse (DeLuca, 2010). Empirical evidence confirms that such integrations improve retention, comprehension, and critical thinking. For instance, Risnita and Bashori (2020) demonstrated through experimental design that essay-based assessments significantly elevate science learning outcomes compared to non-writing controls. Villacrusis (2024) further validates that embedding these strategies in both instruction and materials enhances skills development across reading, writing, and oral domains.

The Department of Education (DepEd), in collaboration with the Department of Science and Technology's Science Education Institute (DOST-SEI) under the Science Teacher Academy for the Region (STAR) project, has implemented targeted trainings to equip teachers with skills for language strategy integration in Science and Mathematics. Notable implementations include workshops in Ilocos Sur (DepEd Schools Division of Ilocos Sur, 2022) and Dagupan City (Division Memorandum No. 305, s. 2022), emphasizing lesson exemplars with vocabulary building, metacognition, and framing techniques. Similar efforts by Saint Louis University (2022) underscore the push for materials that align language supports with curriculum goals.

Teachers' Proficiency in Integrating Language Strategies

The proficiency of teachers in integrating language strategies is a foundation of effective science instruction, enabling educators to link complex scientific content for learners from different linguistic backgrounds in ways that promote fair access and deep comprehension (Sipe *et al.*, 2024; van Driel *et al.*, 2018). Proficient teachers use a variety of scaffolding strategies—including graphic organizers, writing exercises, vocabulary supports, and interactive tasks—to remove obstacles posed by the technical vocabulary demands of abstract reasoning found in scientific texts. This proficiency extends beyond rote application, requiring educators to assess learners' linguistic needs and use strategies dynamically during inquiry-based lessons, thus fostering both communicative competence and content mastery in science discourse.

Empirical studies consistently reveal that sustained professional development significantly improves teachers' confidence, competence, and pedagogical knowledge in integrating language strategies within science classrooms (Education Endowment Foundation, 2024). Such training prepares educators with content-specific language tools, like cueing strategies, theme-related vocabulary brainstorming, and text structure instruction. This collectively enhance learners' comprehension of difficult concepts and their application in oral and written expressions. In the Philippine context, initiatives like DOST-SEI's STAR project underscore this need, as teachers participating in workshops report improved abilities to create lesson exemplars that integrate language strategies seamlessly into science and mathematics instruction; however, systematic proficiency assessments are still not well studied.

Teacher proficiency shows through flexible grouping strategies like pairing English-proficient peers with language learners during activities and adaptive language supports suited to learners' varying proficiency levels. This ensures inclusive participation across monolingual and multilingual classrooms. This integration achieves both goals of simultaneous content mastery and language acquisition, while fostering metacognitive skills that empower learners to assess their own scientific thinking and vocabulary growth (Sipe *et al.*, 2024). Studies reveal patterns in the use of strategies related to different stages of instruction, such as using visual strategies during concept exploration and reflective logs for empirical cycle closure, demanding strong pedagogical content knowledge from teachers.

High proficiency enables teachers to perform dually as content and language mediators, lowering barriers for limited English proficient students by integrating language patterns and activities into science lessons. Despite these benefits, gaps exist in evaluating teachers'

sustained implementation post-training, particularly in aligning strategies with the Revised K-10 Curriculum's emphasis on inquiry and scientific literacy. Addressing this through targeted proficiency measures could enhance student outcomes in science proficiency and academic language development.

Teachers' Challenges in the Use of Language Strategies

Regardless of the benefits of language strategies in enhancing science comprehension, teachers encounter significant challenges in their effective integration into instruction. Primary barriers include limited knowledge of diverse language strategies, insufficient access to specialized training opportunities, constraints of time driven by demanding curriculum coverage, and common misalignment between these strategies and specific science competencies (Gerardo, 2023; National Math and Science Initiative, 2023). In the Philippine context, these issues are deepened by the demands of bilingual policy, where teachers have to address learners' differing proficiency in Filipino and mother tongue while navigating English-medium science resources, which frequently results in inconsistent strategy application.

Time constraints appear as a significant obstacle, as educators struggle to balance between providing a comprehensive content delivery and the significant preparation needed to modify and apply language strategies given their hectic schedules (Srisawat *et al.*, 2021). Teachers frequently report that integrating strategies like graphic organizers or interactive reading guides extends lesson planning time, diverting focus from core scientific processes and risking incomplete coverage of decongested competencies under the Revised K-10 Curriculum. This pressure increases in public elementary schools with limited resources, where large class sizes and administrative duties further hinder opportunities for well-designed language supports.

Alignment and Adaptability Challenges

Moreover, alignment to specific science competencies show as one challenge for teachers. That is, certain language strategies fail to align seamlessly with specific science objectives, requiring teachers to use a great deal of imagination and expertise in order to create linkages between language strategies and conceptual goals (Verma, n.d.). For instance, vocabulary-building exercises may not directly advance inquiry skills, requiring teachers to redesign activities such as changing sentence frames into hypothesis formulation tools—without adequate guidance, which demands advanced knowledge on content-language integration which is sometimes lacking in pre-service training.

Resource and material limitations, showed through poorly designed or linguistically inaccessible learning materials like Learning Activity Sheets (LAS), creates additional challenges for both teachers and learners, maintaining comprehension barriers despite policy requirements for quality assurance via LRMDS (Tabamo, 2023; Caraig & Quimbo, n.d.). These materials frequently exhibit inadequate visual aids, insufficient scaffolding, or mismatched text complexity, requiring teachers to improvise supplements that put further demand on the already limited resources in the classroom. These flaws highlight systemic gaps in material development, where language clarity becomes a secondary priority to content alignment.

Lack of Adequate Training

Teachers encounter considerable challenges due to inadequate pre-service and in-service training on integrating language strategies into science instruction, hindering their ability to address linguistic demands effectively. While initiatives like DOST-SEI STAR project workshops in Ilocos Sur and Dagupan City (DepEd Schools Division of Ilocos Sur, 2022; Division Memorandum No. 305, s. 2022) offer training on the use of language strategies in science and mathematics instruction, these remain irregular without systematic follow-up, resulting in limited long-term proficiency. Teachers frequently lack preparation in content-language tools such as graphic organizers or text structure instruction, particularly for the Revised K-10 Curriculum's inquiry-based demands, resulting in a dependence on ad-hoc rather than evidence-based practices.

Classroom diversity, especially on differing English proficiency, mother tongue backgrounds, and cognitive styles, shows significant challenge for uniform language strategy use. Under DepEd Order No. 010, s. 2024, teachers must adapt supports like sentence frames and translanguaging for monolingual groups despite the large classes and standardized Learning Activity Sheets (LAS) that mismatch learner levels. Poor PISA and TIMSS scores reflect this heterogeneity, which puts teachers under pressure in balancing content coverage with individualized scaffolds for indigenous or rural students, compromising equitable access to scientific literacy.

Consequently, strong professional development programs designed to language strategy integration are indispensable, equipping teachers with practical exemplars, methodological tools, and assessment frameworks to overcome these multifaceted challenges (Pila & Mavuru, 2022). Initiatives like DOST-SEI STAR trainings address this by focusing on workshop-based skill-building, yet their irregular nature and lack of follow-up evaluation limit sustained impact, underscoring the urgency for ongoing, curriculum-embedded support. Enhanced proficiency through such programs could transform challenges into opportunities for equitable science literacy.

MATERIALS AND METHODS

This study employed a systematic literature review (SLR) methodology to comprehensively gather, evaluate, and synthesize existing research related to the integration of language strategies in science education. The review

was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure rigor and transparency in the selection and analysis of relevant literature.

A comprehensive search for relevant literature was undertaken across multiple electronic databases, including Google Scholar, Philippine E-Journals, ResearchGate, ERIC, as well as institutional sources of the Department of Education (DepEd) and the Department of Science and Technology - Science Education Institute (DOST-SEI). Keywords and phrases such as "language strategies in science education," "science learning materials," "teacher proficiency in language integration," and "language challenges in science teaching" were used to identify studies published primarily between 2010 and 2025.

Inclusion criteria encompassed peer-reviewed journal articles, official reports, and dissertations focusing on language strategy integration in science learning and instruction within elementary and secondary education contexts, particularly studies relevant to the Philippine education system. Exclusion criteria removed studies unrelated to science education, those focusing on tertiary-level instruction.

The initial search retrieved a broad quantity of documents which was then screened by title and abstract for relevance. Full-text screening was conducted on shortlisted articles to determine final eligibility. Data extraction from included studies focused on key themes such as language strategies used in learning materials, teacher proficiency levels, and challenges encountered in language integration. Thematic synthesis was employed to categorize findings and identify patterns, ensuring a holistic understanding of the topic.

This literature review approach provided a systematic basis for combining existing knowledge, identifying research gaps, and framing the discussion on language strategy integration in science education.

RESULTS AND DISCUSSION

The integration of language strategies in science education plays a crucial role in addressing gaps in comprehension, fostering student engagement, and enhancing learning outcomes. This section presents the synthesized results and discussion drawn from the reviewed literature to address three themes: (1) the language strategies integrated into science learning materials, (2) the teachers' proficiency in integrating these language strategies, and (3) the teachers' challenges face in integrating these language strategies. By exploring these themes, the discussion provides a comprehensive understanding of how language facilitates science learning in the Philippine context, particularly under the Revised K-10 Curriculum program.

The findings are organized thematically to reflect the structure of the themes. For each theme, relevant research outputs are highlighted to explain how language strategies is connected within science classrooms, the teachers' proficiency to use such strategies effectively, and the challenges that may hinder successful implementation. This approach underscores the multifaceted nature of language integration and its critical link with science pedagogy.

Language Strategies Integrated in the Learning Materials for Science

The literature reveals that a variety of language strategies are systematically integrated into science learning materials, aiming to scaffold students' comprehension of complex scientific concepts and academic language. These strategies focus on both language proficiency and cognitive processing and include linguistic, visual, interactive, and collaborative components.

• Vocabulary Support and Technical Language Simplification. One prominent strategy is the incorporation of vocabulary-building techniques such as keyword banks, sentence frames, and thematic vocabulary lists. These approaches support learners in decoding and appropriately using scientific terminology, which is often a major barrier to comprehension (Bresser & Fargason, 2023; Childs & Ryan, 2016). Simplifying technical language helps learners bridge everyday language to academic science language (Sipe *et al.*, 2024).

• Visual Language Supports. Graphic organizers including concept maps, flow charts, Venn diagrams, and semantic webs among others are extensively integrated in materials to provide spatial and relational representations of scientific ideas (Wise & Cooper, 2019; Candidorio, 2010; DeLuca, 2010). Visual tools serve as cognitive scaffolds that aid pattern recognition, reduce cognitive load, and foster conceptual comprehension.

• Writing and Creative Expression. Writing-based strategies like essays and poetry are integrated to foster critical synthesis, higher-order thinking, and scientific communication skills. Poetry uses metaphor and imagery to deepen conceptual engagement and retention, while essays enable students to communicate scientific explanations cohesively (Barbosa *et al.*, 2014; Heiss, 2024). Dramatizations and stage plays in materials further promote active emotional and cognitive engagement by humanizing science content (Tshuma & Nyamupangedengu, 2024).

• Interactive and Collaborative Strategies. Collaborative reading guides, speech choirs, and gamification strategies encourage active participation and social interaction, important for scientific discourse competence and language development (Saint Louis University, 2022; DepEd Ilocos Sur, 2022).

Teachers' Proficiency in Integrating Language Strategies

One of the essential factors influencing the effectiveness and quality of science teaching is the teachers' proficiency in integrating language strategies into science instruction, especially in linguistically diverse educational contexts like Philippines. Proficiency in this domain involves not

Table 1: Language Strategies in Science Learning Materials, Researchers, and Key Findings

Language Strategy	Researchers	Key Findings
Vocabulary Banks and Sentence Frames	Bresser & Fargason (2023); Childs & Ryan (2016)	These language strategies enhance technical vocabulary comprehension and enable students to communicate scientific ideas.
Graphic Organizers (concept maps, flow charts)	Wise & Cooper (2019); Candidorio (2010); DeLuca (2010)	These language strategies help visualize complex concepts, organize information, and improve retention.
Essays	Risnita & Bashori (2020)	This language strategy fosters scientific writing skills, critical thinking, and coherent articulation of concepts.
Poetry	Barbosa et al. (2014); Brown (2015); Heiss (2024)	It utilizes metaphor and imagery to build deeper understanding and creative scientific expression.
Stage Plays & Dramatization	Tshuma & Nyamupangedengu (2024)	These language strategies support engagement and make abstract science topics tangible and memorable through role-play.
Interactive and Collaborative Tasks (reading guides, speech choir, gamification)	Saint Louis University (2022); DepEd Ilocos Sur (2022)	These language strategies promote social learning, active participation, and improve scientific discourse abilities.

only familiarity with various language support strategies but also the pedagogical skill to integrate such strategies seamlessly with science content to optimize student learning outcomes.

Research tells that teachers who demonstrate high proficiency in language strategy integration are better equipped to identify students' language needs, select appropriate scaffolding tools, and create inclusive, interactive learning environments (Sipe *et al.*, 2024). This proficiency involves an understanding of the unique linguistic demands of scientific discourse, such as specialized vocabulary and explanatory structures, in addition with the ability to facilitate language development through varied instructional modalities such as graphic organizers, conceptual dialogue, and productive writing tasks (Childs & Ryan, 2016; Bresser & Fargason, 2023).

Professional development initiatives have been helpful in enhancing teachers' competencies in this area. Targeted training programs like those offered under the DOST-SEI Science Teacher Academy for the Region (STAR) have equipped educators with both practical skills and theoretical understanding for language strategy use (DepEd Schools Division of Ilocos Sur, 2022). Such programs focus on strategy selection, lesson planning, pedagogical content knowledge, and the creation of instructional materials that are linguistically accessible and encourages ongoing skill improvement.

However, mastery of language integration requires adapting strategies to diverse classroom contexts and identifying complex instructional choices. Teachers proficient in this integration are skilled at diagnosing language-related learning barriers and employing differentiated supports such as language strategies.

Nevertheless, research highlights differences in teachers' reported proficiency levels, often linked to gaps in resource availability, training quality, and school support. While some teachers confidently use a wide array of language strategies, others may display limited or inconsistent use due to gaps in knowledge, lower confidence, or perceived challenges balancing language strategies with content coverage pressures (Gerardo, 2023; National Math and Science Initiative, 2023).

The relationship of systemic support and teacher proficiency remains critical. Facilities allowing regular, targeted professional growth together with access to appropriately designed learning materials significantly increase teacher effectiveness in language strategy integration. This suggests the need for constant investment in teacher education and resource development to ensure that proficiency gains are reflected into consistent, impactful classroom practice.

Teachers' Challenges in Integrating Language Strategies in Science Teaching

Integrating language strategies into science education is recognized as essential for fostering students' comprehension, critical thinking, and academic success. However, despite the growing acknowledgment of this need, teachers encounter variety of challenges that hinder effective implementation. These challenges are multifaceted, ranging from pedagogical constraints and individual teacher preparedness to system issues involving curriculum demands and resource availability.

The difficulty of language use in science classrooms, where teachers must simultaneously scaffold academic language and convey content knowledge, adds pressure to their instructional planning and practice. These two responsibilities are further loaded by factors such as diverse learner backgrounds, large class sizes, and limited instructional time. As a result, teachers often experience decreased efficacy, frustration, and occasional resistance toward constant integration of language strategies.

In addition, the educational context of many Philippine public schools includes additional challenges such as

lack of adequate training, time constraints, resource limitations, alignment issues, and diverse learner needs. Addressing these challenges is crucial for attaining meaningful integration of language strategies that can bridge the gap between the demands of scientific education and the students' linguistic capabilities. The following explains the primary challenges reported in the literature and observed in practice.

• Lack of Adequate Training. One of the most persistent challenges is the inadequate training and professional development opportunities available to teachers. Many Science educators report that they lack sufficient pre-service preparation and in-service training specific to integrating language strategies with science content. Gerardo (2023) emphasizes that most teachers are unaware of the pedagogical tools and techniques necessary for effective linguistic scaffolding, which results in a reliance on traditional, content-centered teaching practices that often neglect the language component essential for comprehension.

• Time Constraints. Time constraints represent another significant problem. Philippine science curricula are congested with contents, driven by the need to cover wide-ranging topics within limited instructional hours. Teachers often find that they do not have sufficient time to explicitly plan, implement, and evaluate the effectiveness of language strategies in their lessons. The pressure to prepare students for assessments and meet curriculum standards means that integrating language strategies such as vocabulary development activities, visual aids, or interactive activities becomes an additional burden rather than a seamless part of content delivery (Srisawat *et al.*, 2021). Consequently, many teachers resort to inconsistent use of language strategies without the depth required to create an improvement in student comprehension.

• Resource Limitations. Many learning resources in the Philippine public school system are either outdated, poorly designed, or linguistically inaccessible. Tabamo (2023) highlights that existing materials often utilize complex sentence structures, overly technical vocabulary, and dense texts that frustrate learners, especially those with limited English proficiency. Teachers are left to modify and supplement these resources on their own, which demands extra time and effort, often beyond their capacity. Without instructional materials that actively integrate appropriate language strategies, teachers find it difficult to consistently employ effective language strategies.

• Alignment Issues. Aligning language strategies with specific science content and assessment standards is another difficult issue faced by teachers. Effective integration requires an understanding of both language and science pedagogies, as well as the ability to select strategies that appropriately address students' linguistic and cognitive needs. Unfortunately, many teachers lack these two skills, leading to strategies that are either too shallow or misaligned with learners' actual needs (Verma, n.d.). This misalignment may result in ineffective scaffolding, which hinders student comprehension and decreases the potential impact of linguistic supports.

• Diverse Learner Needs. The diversity in learners' backgrounds on language continues to present a difficult challenge, especially in multilingual classrooms. The Philippines' socioeconomic and linguistic landscape is diverse, with many students from regional and indigenous communities speaking languages other than English or Filipino at home. Teachers struggle to adapt their language strategies to suit this classroom setting. While the policy advocates for multilingual approaches, teachers often lack the training, resources, or institutional support to implement them effectively. They are forced to use a one-size-fits-all approach that inadequately addresses individual learner needs, leading to gaps in engagement and understanding.

CONCLUSION

The literature review identifies diverse language strategies such as vocabulary supports, visual aids, writing tasks, and collaborative activities which are integrated into Philippine science learning materials to enhance student comprehension and engagement. Teacher proficiency in these strategies improves through professional development like DOST-SEI STAR workshops but remains limited by inadequate training, time pressures, resource limitations, and diversity of learners' needs. Key challenges encompass curriculum misalignment, infrequent training programs (DepEd Schools Division of Ilocos Sur, 2022), deficient Learning Activity Sheets (Tabamo, 2023), and multilingual needs under DepEd Order No. 010, s. 2024, which directly contributes to persistent low TIMSS/PISA performance. Addressing these through sustained training, coherent policies, and quality-assured materials via LRMDS is essential for improving science literacy in the Revised K-10 Curriculum, with this study providing empirical insights on integration, proficiency, and challenges in Ilocos Norte to guide inclusive pedagogy.

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