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Instructional Leadership Development Support for Science Teachers

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ABSTRACT

This study investigated Instructional Leadership Development Support for Science Teachers in the Division of Surigao del Norte as a basis for professional development. Specifically, it examined teachers' demographic profiles in terms of years of teaching and science trainings attended, assessed their level of understanding across four global warming concepts: greenhouse effect, acid rain, ozone depletion, and radiation, and determined the relationship and differences between their understanding and demographic variables. Using a quantitative-descriptive correlational design, data were gathered from 50 science teachers through a validated multiple-choice test and analyzed using frequency, percentage, mean, Pearson's r , and ANOVA. Findings revealed that most teachers were early in their careers and had limited exposure to training. Overall, their understanding was categorized as high-moderate, with better comprehension in greenhouse effect and radiation, and weaker understanding in acid rain and ozone depletion. A significant positive relationship was found between years of teaching and understanding of ozone depletion and radiation. ANOVA results also showed significant differences in conceptual understanding based on teaching experience and the number of trainings attended, particularly for ozone depletion and radiation. The study concludes that teaching experience influences science teachers' conceptual understanding more than training frequency. It recommends targeted, content-specific professional development and curriculum improvements to address identified knowledge gaps and enhance climate change education.

Introduction

Science education requires teachers who possess strong scientific understanding and are supported by instructional leaders who can sustain their professional growth. In environmental science, this responsibility becomes more critical because concepts such as global warming, greenhouse effect, acid rain, ozone depletion, and radiation are complex and highly interconnected. Climate change education has become essential in preparing learners to understand environmental risks and participate in responsible action (UNESCO, 2019). However, the effectiveness of climate science instruction depends largely on teachers' conceptual understanding and the quality of instructional support provided within schools.

Science teachers play a vital role in translating complex environmental concepts into meaningful classroom learning experiences. According to Shulman's (1986) pedagogical content knowledge framework, effective teaching requires not only mastery of scientific content but also the ability to present concepts in ways that learners can easily understand. When teachers possess incomplete or inaccurate conceptual understanding, misconceptions may also be transferred to learners, weakening the quality of science instruction.

Despite the integration of climate and environmental concepts in science curricula, studies continue to report misconceptions among science teachers regarding global warming, greenhouse effect, ozone depletion, acid rain, and radiation (Boon, 2010; Papadimitriou, 2004; Shepardson et al., 2011). These findings suggest that many teachers still require sustained professional support to strengthen both content knowledge and instructional practice. Existing professional development programs are often broad and generalized, providing limited attention to specific conceptual gaps experienced by science teachers in environmental science topics.

The challenge becomes more significant because environmental science concepts are scientifically related yet conceptually distinct. Ozone depletion is frequently confused with global warming, while radiation is often viewed only as a harmful phenomenon without understanding its role in atmospheric and energy processes (David et al., 2021). Similarly, acid rain is sometimes discussed without sufficient explanation of its chemical causes and environmental effects. These persistent misconceptions indicate the need for focused and content-specific instructional leadership development support rather than routine supervisory practices or generic seminars.

In the Philippine context, environmental education is strengthened through Republic Act No. 9512 and Republic Act No. 9729, which promote environmental awareness and climate change education in schools. However, policy integration alone does not guarantee effective classroom implementation. Teachers still require sustained school-based support, updated instructional resources, and targeted professional development to ensure scientifically accurate and pedagogically sound instruction in environmental science.

This concern is particularly relevant in the DepEd Division of Surigao del Norte, where science teachers are expected to deliver climate science lessons in a coastal and disaster-prone province frequently affected by typhoons and flooding. Preliminary consultations and anecdotal observations suggest that many teachers experience limited training opportunities, insufficient instructional resources, and challenges in mastering key climate science concepts. Although climate resilience and environmental sustainability are emphasized in the curriculum, gaps in conceptual understanding may still affect instructional effectiveness in the classroom.

While previous studies have explored climate change education and environmental awareness, limited research has focused specifically on the conceptual understanding of Junior High School science teachers in the Philippine setting and its connection to instructional leadership development support. Moreover, there remains a lack of localized empirical evidence identifying teachers' specific conceptual gaps as a basis for

targeted professional development interventions. Addressing this gap, the present study seeks to assess the conceptual understanding of science teachers in environmental science and use the findings as a foundation for developing responsive instructional leadership support programs in the DepEd Division of Surigao del Norte.

Framework of the Study

This study is anchored on three interrelated theories, such as Constructivist Learning Theory (Piaget, 1970; Vygotsky, 1978). Pedagogical Content Knowledge Framework (Shulman, 1987), and Instructional Leadership Theory (Hallinger, 2005). These theories provide the foundation for understanding how science teachers develop conceptual understanding, how they transform scientific knowledge into meaningful classroom instruction, and how school-based leadership can support their professional growth. The framework emphasizes that improving science instruction requires both teacher learning and leadership-guided support systems.

Constructivist Learning Theory supports the idea that science teachers' conceptual understanding of the greenhouse effect, acid rain, ozone depletion, and radiation can be improved through guided and collaborative learning experiences. Teachers do not simply receive knowledge passively from seminars or training sessions; rather, they deepen their understanding when they engage in discussion, analyze misconceptions, connect concepts to classroom situations, and apply new knowledge in instruction. Thus, instructional leadership development support should provide science teachers with opportunities for reflection, peer collaboration, mentoring, and contextualized learning so that they can strengthen their scientific understanding and correct possible misconceptions.

The study is also grounded in Shulman's Pedagogical Content Knowledge Framework, which states that effective teaching requires the integration of subject matter knowledge and pedagogy. Teachers must not only know the content they teach; they must also know how to explain, represent, and simplify that content for learners. In science education, this is especially important because environmental science topics are conceptually complex and often prone to misunderstanding. A science teacher may be familiar with the terms: greenhouse effect, acid rain, ozone depletion, and radiation, but effective instruction requires a deeper understanding of their causes, processes, effects, and distinctions.

In this study, Pedagogical Content Knowledge serves as a lens for understanding the instructional needs of science teachers. The framework assumes that teachers' conceptual understanding directly influences how they design lessons, answer learners' questions, select examples, use instructional materials, and correct misconceptions in the classroom. Therefore, instructional leadership development support should not only focus on increasing teachers' content knowledge but also on strengthening their ability to teach environmental concepts clearly and meaningfully. This may include support in preparing lesson exemplars, developing localized instructional materials, using visual models and simulations, designing inquiry-based activities, and applying assessment strategies that reveal students' misconceptions.

The third theoretical anchorage of the study is Instructional Leadership Theory. This theory emphasizes the role of school leaders in improving teaching and learning by setting instructional directions, supervising instruction, supporting teacher development, monitoring learning progress, and creating a school culture focused on academic improvement. In this study, instructional leadership is viewed not merely as administrative supervision, but as a developmental process that helps science teachers grow professionally. School heads, department heads, master teachers, and other instructional leaders are expected to provide structured support that responds to teachers' actual instructional needs. Instructional Leadership Theory is particularly relevant because the study seeks to develop support for science teachers based on their conceptual understanding of environmental issues. If teachers encounter difficulty in explaining certain science concepts, instructional leaders can help by organizing focused professional development, facilitating Learning Action Cell sessions, promoting peer coaching, encouraging lesson study, and providing constructive

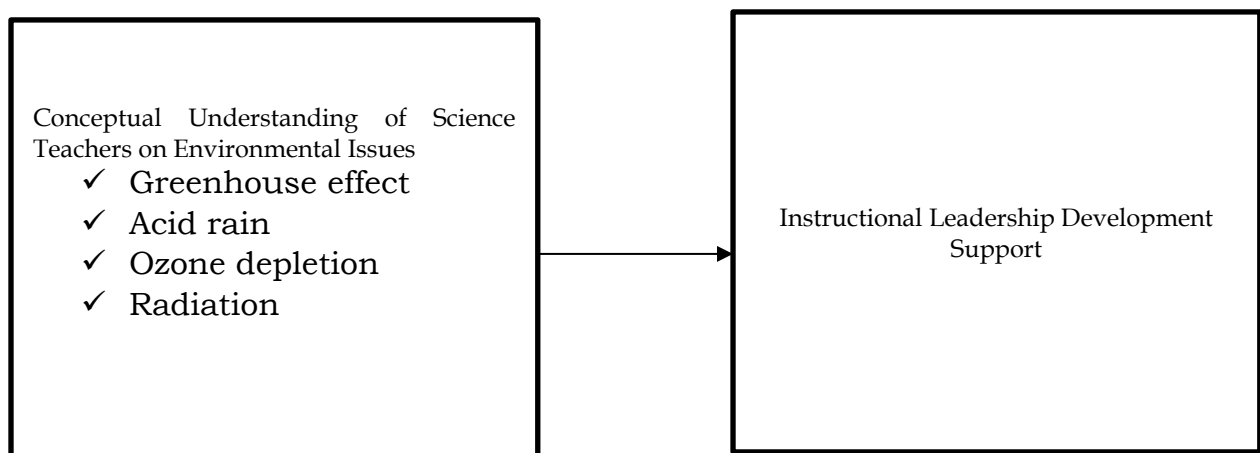
feedback after classroom observation. In this sense, instructional leadership becomes the bridge between teachers’ existing level of understanding and the desired improvement in classroom practice. It ensures that teacher development is not left to individual effort alone, but is supported by a systematic school-based mechanism.

Taken together, these three theories form the foundation of the study. Constructivist Learning Theory explains how teachers learn and reconstruct scientific understanding; Pedagogical Content Knowledge Framework explains how teachers transform scientific concepts into teachable classroom content; and Instructional Leadership Theory explains how school leaders can organize support systems that strengthen teacher competence. Through these theoretical lenses, the study assumes that science teachers’ conceptual understanding can be improved when instructional leaders provide relevant, sustained, and evidence-based development support.

Conceptually, the study begins with the assessment of science teachers’ conceptual understanding of selected environmental issues, namely, greenhouse effect, acid rain, ozone depletion, and radiation. These areas serve as the basis for identifying teachers’ instructional strengths and support needs. The process involves analyzing teachers’ level of understanding and determining the areas that require conceptual clarification and instructional improvement. The expected output is an Instructional Leadership Development Support mechanism for science teachers, which may include content-focused professional development, mentoring, coaching, Learning Action Cell sessions, peer collaboration, lesson study, instructional materials development, and continuous monitoring and feedback.

Thus, the framework of the study positions instructional leadership as a vital support system for improving science teaching. It recognizes that science teachers need both conceptual mastery and pedagogical guidance to teach environmental science effectively. By integrating constructivist learning, pedagogical content knowledge, and instructional leadership, the study provides a strong basis for developing school-based support that enhances teachers’ scientific understanding, strengthens instructional delivery, and contributes to improved environmental science education.

Figure 1. Schematic Diagram of the Study



Statement of the Problem

This study aimed to determine the conceptual understanding of Junior High School science teachers on selected environmental issues as a basis for initiating instructional leadership development support. It further assessed science teachers' understanding of the greenhouse effect, acid rain, ozone depletion, and radiation among Junior High School science teachers in selected schools in the Division of Surigao del Norte during School Year 2022–2023.

Specifically, it sought to answer the following questions:

1. What is the conceptual understanding of science teachers regarding the four environmental issues:
 - 2.1 Greenhouse effect;
 - 2.2 Acid rain
 - 2.3 Ozone depletion; and
 - 2.4 Radiation?
2. Based on the findings, what instructional leadership development support can be initiated?

Significance of the Study

This study provides a basis for strengthening science instruction through instructional leadership development support. The findings may help shift professional development from general training activities to more targeted, evidence-based, and concept-specific instructional support.

Science teachers are direct beneficiaries of this study because the results may help them recognize their strengths and areas for improvement in understanding environmental science concepts. The proposed instructional leadership development support can provide them with opportunities to clarify misconceptions, deepen their scientific explanations, improve lesson planning, and apply more appropriate teaching strategies. As a result, teachers may become more confident and accurate in teaching global warming-related topics.

This study may help *school heads and administrators* identify the areas where science teachers need instructional support in teaching environmental science concepts. The results can guide them in planning school-based professional development programs, organizing mentoring sessions, strengthening Learning Action Cells, and providing instructional resources that address teachers' conceptual gaps. Through this, administrators can exercise instructional leadership not only through supervision but also through sustained teacher development.

The study is useful for *department heads, science coordinators, and master teachers* because it provides a clear basis for designing coaching, mentoring, peer observation, and lesson study activities. Since the study focuses on teachers' understanding of the greenhouse effect, acid rain, ozone depletion, and radiation, instructional leaders can use the findings to prepare focused interventions that help teachers improve both content mastery and classroom delivery. This allows instructional leadership to become more diagnostic, collaborative, and improvement-oriented.

Learners may benefit from the study because improved teacher understanding can lead to clearer, more accurate, and more meaningful science instruction. When science teachers receive appropriate instructional support, they are better able to explain environmental concepts, correct misconceptions, use relevant examples, and connect lessons to real-life environmental concerns. This can help learners develop stronger scientific literacy and greater awareness of climate-related issues.

The study may provide *curriculum planners and developers* with empirical information on which environmental science concepts require stronger instructional support. The results can help inform the preparation of learning materials, lesson exemplars, enrichment activities, and teacher guides that respond to common areas of conceptual difficulty. This is important in ensuring that environmental education is not only

included in the curriculum but also effectively taught in the classroom.

This study may assist *DepEd officials, supervisors, and policymakers* in designing more responsive teacher development programs in science education. Since climate change and environmental awareness are part of national educational priorities, the study may serve as a basis for initiating division-level or district-level instructional leadership programs that strengthen teachers' competence in environmental science. It may also support policy directions that emphasize continuous professional development, instructional supervision, and school-based teacher support.

Future researchers may use this study as a reference for related investigations on science teachers' conceptual understanding, instructional leadership, professional development, and environmental science education. The study may also serve as a basis for developing intervention studies, leadership support models, or training programs that examine how instructional leadership can improve teachers' content knowledge and pedagogical practice.

Review of Related Literature

The literature and studies related to environmental science education, conceptual understanding, environmental issues, and instructional leadership development support. The review provides the legal, scientific, and educational foundations of the study and highlights the gaps that justify the need for localized instructional leadership support for science teachers.

Legal Bases of Environmental Education

Environmental education in the Philippines is strengthened through Republic Act No. 9512 and Republic Act No. 9729, which promote environmental awareness and climate change education across all educational levels. The K-12 curriculum integrates climate change, disaster risk reduction, and environmental sustainability concepts in science and related subjects. DepEd also supports environmental programs such as tree planting, solid waste management, and climate education initiatives through school-based activities and instructional resources. Despite these national policies and programs, studies revealed that many science teachers still experience limited training opportunities, inadequate instructional resources, and insufficient mastery of climate science concepts (David et al., 2021; Taboada et al., 2019). This literature is significant to the present study because it establishes the gap between policy implementation and actual classroom preparedness, emphasizing the need for instructional leadership support that strengthens teachers' conceptual understanding and teaching competence in environmental science.

Teaching for Conceptual Understanding in Science

Conceptual understanding refers to the ability to connect scientific facts with underlying principles and apply them meaningfully in real-life situations. Studies emphasized that meaningful science learning occurs when concepts are clearly understood rather than memorized (Novak, 2010; Bransford et al., 2000). In science education, teachers with weak conceptual understanding may unintentionally transfer misconceptions or fragmented explanations to learners. Research further showed that conceptual change requires reflective, inquiry-based, and collaborative learning experiences (Perkins, 1993; Smith, 1991). Effective science teaching should therefore encourage discussion, concept clarification, and connections between scientific concepts and daily experiences. This literature is relevant to the study because it highlights the importance of strengthening science teachers' conceptual understanding as a foundation for accurate classroom instruction and effective environmental science education.

Environmental Issues in Science Education

Studies consistently revealed that science teachers often experience misconceptions regarding global warming, greenhouse effect, acid rain, ozone depletion, and radiation (Shepardson et al., 2011; Boon, 2010; Papadimitriou, 2004). Teachers commonly confuse ozone depletion with global warming, misunderstand the greenhouse effect,

and associate radiation only with harmful or nuclear processes. In addition, limited access to updated instructional materials and insufficient professional development contribute to weak conceptual understanding among teachers (David et al., 2021). Literature also emphasized that climate change and environmental science are complex socio-scientific issues requiring strong scientific understanding and contextualized teaching approaches. Inquiry-based instruction, collaborative learning, simulations, and localized examples were identified as effective strategies for improving conceptual understanding in science education. These studies are significant to the present research because they identify the specific conceptual gaps experienced by science teachers and support the need for targeted instructional leadership interventions focused on environmental science concepts.

Factors Affecting Teachers' Conceptual Understanding

Research showed that teachers' conceptual understanding and environmental attitudes vary according to teaching experience, academic preparation, and participation in professional development programs (Lee et al., 2015; Taboada et al., 2019; Chang & Pascua, 2017). Teachers who attended environmental education seminars and training demonstrated stronger content mastery and greater confidence in teaching climate-related topics compared to those with limited exposure to professional development. Studies further emphasized that sustained and content-focused professional development is necessary to improve both scientific knowledge and pedagogical competence (Guskey, 2002; UNESCO, 2021). This literature is important to the present study because it supports the assumption that instructional leadership development support can strengthen teachers' conceptual understanding and instructional effectiveness through targeted and continuous professional learning opportunities.

Instructional Leadership Development Support in Science Education

Instructional leadership development support refers to organized school-based assistance designed to improve teachers' content knowledge, pedagogical skills, and classroom instruction. Hallinger and Murphy (1985) emphasized that instructional leadership focuses on improving teaching and learning through supervision, mentoring, professional development, and instructional support. In science education, instructional leadership becomes essential because environmental science topics require conceptual clarity and accurate scientific explanation. Studies highlighted that effective instructional leadership should be diagnostic, collaborative, evidence-based, and responsive to teachers' actual learning needs. Professional learning structures such as mentoring, Learning Action Cell (LAC) sessions, peer coaching, lesson study, and continuous feedback help teachers improve conceptual understanding and teaching practices (Desimone, 2009). This literature is highly significant to the present study because it provides the foundation for developing an Instructional Leadership Development Support mechanism intended to address the identified conceptual gaps of science teachers in environmental science.

Methodology

Research Design

This study employed a quantitative descriptive research design to determine the level of conceptual understanding of Junior High School science teachers on greenhouse effect, ozone depletion, acid rain, and radiation as a basis for instructional leadership development support. Descriptive research was used to describe and analyze the teachers' conceptual understanding through statistical treatment of data.

Research Locale

The study was conducted during School Year 2022–2023 in eight selected public Junior High Schools in the Division of Surigao del Norte. The schools were selected because they offer Science subjects from Grades 7 to 10, where environmental science concepts are integrated. The locale was considered appropriate due to its varied school contexts, science-related programs, and environmental education activities. Since Surigao del

Norte is a disaster-prone province frequently affected by typhoons and flooding, the setting further emphasized the relevance of environmental science education and the need to assess teachers' conceptual understanding.

Participants of the Study

The participants of the study were fifty (50) Junior High School science teachers from selected public secondary schools in the Division of Surigao del Norte. They were directly teaching Science subjects in Grades 7 to 10 during School Year 2022–2023. The participants had varied teaching ranks, experiences, and professional backgrounds, which provided a broader representation of science teachers within the division.

Sampling Procedure

The study used simple random sampling with proportionate allocation. The total number of eligible science teachers in each participating school was identified, and proportionate allocation was applied to ensure fair representation. The fishbowl method was then used to randomly select the participants from each school until the required sample size of fifty teachers was achieved.

Research Instrument

The study utilized a researcher-made two-tiered questionnaire consisting of forty (40) modified multiple-choice items covering greenhouse effect, ozone depletion, acid rain, and radiation. The instrument was based on the Grade 7–10 Science curriculum competencies and designed to measure teachers' conceptual understanding. The first tier assessed content knowledge, while the second tier required participants to justify their answers to determine the depth of conceptual understanding.

Validation of the Instrument

The instrument underwent expert validation by science education specialists to ensure content validity and reliability. It was pilot-tested among thirty (30) science teachers from two junior high schools outside the study locale. Reliability testing using Cronbach's alpha yielded a coefficient of 0.80, indicating that the instrument was reliable and internally consistent.

Scoring Procedure

Teachers' responses were scored using a modified rubric adapted from Licayan (2010). The rubric categorized conceptual understanding into five levels: Scientifically Correct Understanding, Partially Correct Understanding, Functional Understanding, Incorrect Understanding, and Worst Understanding. These categories served as the basis for interpreting the teachers' conceptual understanding of the four environmental science concepts.

Ethical Considerations

Ethical standards were strictly observed throughout the conduct of the study. Permission was secured from the Schools Division Office and participating school heads before data gathering. The participants were informed about the purpose of the study, and informed consent was obtained before participation. Confidentiality, anonymity, voluntary participation, and proper handling of data were ensured to protect the rights and welfare of the participants.

Data Gathering Procedure

Upon approval from the concerned authorities, the researcher personally administered the two-tiered assessment to the participants during their available time. Instructions were clearly explained before the administration of the instrument. After the assessment, the questionnaires were collected, checked, and prepared for data analysis. Additional survey responses regarding factors affecting conceptual understanding were also gathered to support data interpretation.

Data Analysis

The data were analyzed using frequency and percentage to determine the level of conceptual understanding of the teacher-participants in greenhouse effect, acid rain, ozone depletion, and radiation. Conceptual analysis was also employed to identify teachers' strengths, misconceptions, and conceptual gaps. The findings served as the basis for proposing instructional leadership development support programs for science teachers. Results and discussion The findings on Junior High School science teachers' conceptual understanding of the four environmental issues: greenhouse effect, acid rain, ozone depletion, and radiation. It also discusses the patterns of understanding and uses these results as basis for proposing instructional leadership development support to strengthen science teaching in environmental education.

Conceptual Understanding of Science Teachers on Environmental Issues

Science teachers play a vital role in translating complex environmental concepts into meaningful classroom learning experiences. As such, assessing their conceptual understanding of global warming-related issues provides important insights into their readiness to teach these topics accurately and effectively. The findings focus on how teachers understand four major environmental concepts commonly associated with global warming.

The findings indicate that Science Teachers generally demonstrate a moderate but uneven conceptual understanding of global warming-related environmental issues. Most of the respondents were classified under Partially Correct Understanding rather than Scientifically Correct Understanding, suggesting that while teachers possess basic knowledge of the concepts, many still hold incomplete or less precise scientific explanations. Among the four areas, the greenhouse effect emerged as the strongest, with 48% of teachers showing partially correct understanding and 38% demonstrating scientifically correct understanding, while no respondents fell under incorrect or worst understanding. Radiation also showed relatively stronger results, with 44% classified under partially correct understanding and 36% under scientifically correct understanding. These results suggest that teachers have acquired foundational knowledge in these areas, yet deeper conceptual clarity is still needed for more accurate and comprehensive scientific interpretation.

On the other hand, more pronounced conceptual gaps were found in acid rain and ozone depletion. In both areas, only 14% of teachers reached the scientifically correct level of understanding. In acid rain, the majority of responses were distributed across partially correct and functional understanding, while a notable proportion demonstrated incorrect or worse understanding. A similar pattern appeared in ozone depletion, where many teachers showed only partial or functional understanding, alongside some incorrect conceptions. This suggests that although teachers are not entirely unfamiliar with global warming-related issues, their knowledge remains fragmented and susceptible to misconceptions, particularly in topics that require clearer scientific differentiation. The findings underscore the need for targeted professional development support that will enhance teachers' conceptual understanding, address misconceptions, and strengthen their confidence in teaching environmental science concepts effectively.

Table 1. Conceptual Understanding of Global Warming in terms of the Greenhouse Effect

Level of Conceptual Understanding	Frequency (n=50)	Percentage (%)	Interpretation
Scientifically Correct Understanding (SCU)	19	38%	Demonstrates accurate, comprehensive, and scientifically grounded knowledge
Partially Correct Understanding (PCU)	24	48%	Shows general understanding but with minor inaccuracies or misconceptions
Functional Understanding (FU)	7	14%	Able to use basic concepts functionally, but lacks depth or clarity
Incorrect Understanding (IU)	0	0%	Holds clearly incorrect conceptions not aligned with scientific evidence
Worst Understanding (WU)	0	0%	Demonstrates an absence or a complete misunderstanding of the concept
Total	50	100%	

Table 2 presents the level of conceptual understanding of Junior High School Science Teachers on global warming in terms of the greenhouse effect, categorized into five levels: Scientifically Correct Understanding (SCU), Partially Correct Understanding (PCU), Functional Understanding (FU), Incorrect Understanding (IU), and Worst Understanding (WU). The distribution of responses among 50 teachers provides insight into how well they comprehend this specific environmental concept.

The highest level of understanding identified in the table is Partially Correct Understanding (PCU), with 24 out of 50 teachers, or 48%, falling under this category. This indicates that nearly half of the respondents hold a general understanding of the greenhouse effect but still retain minor misconceptions. According to Treagust (2006), such partially formed scientific conceptions are common and often persist due to insufficient conceptual change in both pre-service and in-service teacher education.

The lowest level, shared by both Incorrect Understanding (IU) and Worst Understanding (WU), received 0% of the responses, indicating that none of the teachers held completely inaccurate or absent knowledge of the greenhouse effect. This is a positive result, suggesting that all respondents at least possess some degree of scientific awareness on the topic.

Overall, the data show that most teachers (86%) have either a scientifically correct or partially correct understanding of the greenhouse effect. While this reflects a generally satisfactory level of conceptual knowledge, the prevalence of partial understanding points to the need for continuous professional development. As emphasized by Driver et al. (1994), improving teachers' scientific understanding is critical, as their knowledge significantly influences students' learning and shapes classroom discourse on key environmental issues such as global warming.

Table 2. Conceptual Understanding of Global Warming in terms of Acid Rain

Level of Conceptual Understanding	Frequency	Percentage	Interpretation
Scientifically Correct (SCU)	7	14%	Accurately explains acid rain, including causes and effects.
Partially Correct (PCU)	17	34%	Contains partial understanding; may miss causes or confuse processes.
Functional Understanding (FU)	15	30%	Uses general environmental knowledge; lacks scientific precision.
Incorrect Understanding (IU)	9	18%	Misunderstands core concepts, potentially confusing acid rain with other effects.
Worst Understanding	2	4%	Completely lacks an accurate understanding.

(WU)	Total	50	100%
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Table 3 displays the level of conceptual understanding of Junior High School Science Teachers on global warming in terms of acid rain. Teachers’ responses are grouped according to five levels of understanding, based on their scores from a structured multiple-choice assessment. These levels include Scientifically Correct Understanding (SCU), Partially Correct Understanding (PCU), Functional Understanding (FU), Incorrect Understanding (IU), and Worst Understanding (WU). The distribution provides insights into the depth and accuracy of their scientific knowledge regarding acid rain—its causes, processes, and impacts.

The highest proportion of responses falls under the Partially Correct Understanding (PCU) level, with 34% (n=17) of teachers demonstrating a general yet incomplete understanding of acid rain. This suggests that while some concepts are grasped, misconceptions still exist—such as confusion between contributing pollutants or processes involved. This finding aligns with Treagust (2006), who emphasized that incomplete conceptual frameworks are often retained due to surface-level exposure to scientific content without adequate reinforcement or correction.

In contrast, the lowest category is Worst Understanding (WU), accounting for only 4% (n=2) of the respondents. These teachers demonstrate a complete lack of accurate understanding of acid rain, likely confusing it with unrelated environmental issues or being unfamiliar with its fundamental causes. Although this is a small percentage, it still signals a gap in environmental science literacy among a minority of educators.

Overall, the results indicate that the majority of Junior High School Science Teachers possess less than scientifically accurate knowledge of acid rain, with only 14% (n=7) falling under the Scientifically Correct Understanding (SCU) category. A combined 64% (PCU + FU) reflects partial or functional understanding, which highlights the presence of fragmented knowledge or a lack of precision. These findings stress the importance of strengthening science teachers’ content knowledge through targeted in-service training. As Driver et al. (1994) note, teachers play a critical role in shaping learners’ scientific conceptions, and any misconceptions they hold may directly influence student understanding, especially on pressing environmental concerns like acid rain.

Table 3. Conceptual Understanding of Global Warming in terms of Ozone Depletion

Level of Conceptual Understanding	Frequency	Percentage	Interpretation
Scientifically Correct (SCU)	7	14%	Knows scientific causes (e.g., CFCs) and effects on health and UV radiation.
Partially Correct (PCU)	25	50%	Basic understanding, but may be confused with the greenhouse effect.
Functional Understanding (FU)	10	20%	Limited to everyday associations without a scientific basis.
Incorrect Understanding (IU)	8	16%	Holds misconceptions or inaccurate ideas.
Worst Understanding (WU)	0	0%	No valid understanding presented.
Total	50	100%	

Table 4 presents the level of conceptual understanding of Junior High School Science Teachers regarding ozone depletion, one of the critical strands of global warming-related issues. Responses were categorized into five levels—Scientifically Correct (SCU), Partially Correct (PCU), Functional Understanding (FU), Incorrect Understanding (IU), and Worst Understanding (WU)—based on teachers’ scores in a conceptual test assessing their knowledge of ozone layer depletion, its causes, and effects.

The highest percentage of responses falls under the Partially Correct Understanding (PCU) level, with 50% (n=25) of teachers demonstrating a basic but incomplete understanding. Many in this group appear to know some general ideas but may confuse ozone depletion with the greenhouse effect, which is a well-documented misconception in science education (Treagust, 2006). This high percentage suggests a widespread need to clarify the distinct mechanisms and consequences of ozone depletion.

At the lowest level, Worst Understanding (WU) registered 0%, indicating that none of the teachers completely lacked valid knowledge about the topic. This is an encouraging result as it implies that all respondents have at least some degree of familiarity with the issue, even if incorrect or limited in scope.

Overall, the data show that only 14% (n=7) of the teachers reached the Scientifically Correct Understanding (SCU) level, demonstrating accurate knowledge of causes such as chlorofluorocarbons (CFCs), and the effects of ozone depletion on human health and ultraviolet (UV) radiation. A combined 70% (PCU + FU) of respondents show partial or limited understanding, which suggests the prevalence of conceptual confusion and superficial knowledge. As emphasized by Driver et al. (1994), such misconceptions, if uncorrected, may be transferred to students, thus impeding proper scientific learning. These findings point to a clear need for targeted capacity-building initiatives focused on differentiating global environmental issues, particularly in distinguishing ozone depletion from climate change phenomena.

Table 4. Conceptual Understanding of Global Warming in terms of Radiation

Level of Conceptual Understanding	Frequency	Percentage	Interpretation
Scientifically Correct (SCU)	18	36%	Clearly explains the role of radiation in climate and atmospheric science.
Partially Correct (PCU)	22	44%	Some correct elements, but lacking full conceptual clarity.
Functional Understanding (FU)	2	4%	Practical or vague understanding, likely influenced by media or daily experience.
Incorrect Understanding (IU)	8	16%	Misunderstanding or confusing radiation with unrelated concepts.
Worst Understanding (WU)	0	0%	Lacks knowledge or expresses scientifically inaccurate beliefs.
Total	50	100%	

Table 5 presents the level of conceptual understanding of Junior High School Science Teachers on global warming in terms of radiation, one of the fundamental concepts in atmospheric and climate science. Teachers' responses are classified into five levels based on a structured assessment, ranging from Scientifically Correct to Worst Understanding. The data offers insights into how well educators comprehend the role of radiation in the Earth's energy balance and climate system.

The highest level of understanding is represented by the Partially Correct Understanding (PCU) category, with 44% (n=22) of the respondents. This indicates that while these teachers possess some knowledge of radiation's role in climate processes, their understanding lacks conceptual depth or clarity. This aligns with the findings of Treagust (2006), who notes that many science educators struggle with integrating abstract scientific principles—such as radiative forcing and electromagnetic spectrum interactions—into their teaching due to limited content exposure or cognitive misconceptions.

Following closely, 36% (n=18) of the teachers demonstrated a Scientifically Correct Understanding (SCU). These individuals show a clear and accurate comprehension of radiation's role in climate science, such as the Earth's absorption and emission of infrared radiation and its connection to global temperature regulation. According to Shulman (1987), teachers with deep content knowledge are more capable of supporting

student learning through accurate explanation and integration of scientific principles into classroom discourse.

The lowest level is the Worst Understanding (WU), which recorded 0%, indicating that no teachers expressed complete misunderstanding or scientifically inaccurate beliefs about radiation. This is a positive result, as it suggests that all respondents at least possess some basic awareness of the concept, regardless of accuracy.

Overall, the results indicate that 80% (PCU + SCU) of the teachers possess either fully accurate or partially correct knowledge of radiation in the context of climate change. However, the presence of 16% (n=8) under Incorrect Understanding (IU) and 4% (n=2) under Functional Understanding (FU) implies that some teachers may still confuse radiation with unrelated phenomena (e.g., nuclear radiation or electromagnetic pollution), a common issue in science education as reported by Sadler et al. (2010). This highlights the need for professional development that emphasizes conceptual clarity, particularly in differentiating scientific terms that are commonly misunderstood or misused in popular discourse.

Instructional Leadership Development Support for Science Teachers

The six themes show that the issue is not merely one of teacher deficiency, but of how instructional leadership can systematically organize support, feedback, and professional learning so that science teachers develop stronger conceptual mastery in environmental science. The findings show a moderate but uneven conceptual profile among science teachers, with most respondents falling under Partially Correct Understanding rather than Scientifically Correct Understanding, and with stronger performance in the greenhouse effect and radiation than in acid rain and ozone depletion.

Theme 1: Instructional leadership must begin with teachers' existing strengths, not only with their deficits.

One important pattern in the findings is that teachers already possess a meaningful conceptual base in some areas. The greenhouse effect emerged as the strongest area, with 48% partially correct and 38% scientifically correct, while radiation also showed relatively stronger understanding, with 44% partially correct and 36% scientifically correct. This suggests that science teachers are not starting from conceptual absence; rather, they are operating from partially developed knowledge structures that require refinement and deepening. From an instructional leadership perspective, this means school leaders should not design professional development as generic remediation, but as capacity-building anchored on existing competence. Research shows that instructional leadership is strongly associated with teacher professional development and that leadership practices can substantially predict teachers' growth trajectories. In one study, instructional leadership significantly predicted teacher professional development, explaining a substantial portion of variance in teachers' development outcomes. This implies that school heads should identify strong conceptual entry points—such as teachers' relative competence in greenhouse effect and radiation—and use these as anchors for mentoring, lesson study, and content-enrichment sessions.

Theme 2: Persistent misconceptions signal the need for diagnostic and conceptually targeted professional development.

The findings also reveal that the more serious concern is not total ignorance but persistent misconception. Acid rain and ozone depletion emerged as the weakest areas: only 14% of teachers reached scientifically correct understanding in both topics, while many remained at partially correct, functional, or incorrect levels. For acid rain, the results show a combined 64% in partially correct and functional understanding, with 22% already in incorrect or worse understanding. For ozone depletion, 50% were partially correct, 20% functional, and 16% incorrect. These patterns suggest that teachers may know fragments of environmental science but still confuse mechanisms, causes, and effects. Existing research similarly shows that teachers often hold significant climate-related knowledge gaps and misconceptions, and that these weaken their readiness to implement climate change education effectively. Tang found that teachers' knowledge gaps and misconceptions

remain a major obstacle, even when awareness is high, and that targeted training and resources are needed to address these weaknesses. Thus, instructional leadership support should include diagnostic assessment of misconceptions, followed by focused interventions such as misconception analysis workshops, conceptual change sessions, and content-specific coaching rather than one-shot seminars.

Theme 3: The central leadership challenge is conceptual differentiation across closely related environmental issues.

A deeper reading of the results shows that the problem is not simply weak knowledge, but difficulty in differentiating interconnected environmental concepts. Teachers performed better in the greenhouse effect and radiation, yet struggled markedly in ozone depletion and acid rain, indicating confusion across issues that are often discussed together in the media and public discourse. The file explicitly notes that many teachers may confuse ozone depletion with the greenhouse effect and may interpret radiation using vague or unrelated meanings. This is a major instructional leadership concern because science teaching depends not only on knowing isolated facts but also on understanding boundaries between related scientific ideas. Research on climate and environmental education supports this interpretation. Tolppanen et al. found that pre-service teachers frequently misjudge the relative impact of different climate actions and often fail to distinguish low-impact from high-impact mitigation choices, showing that fragmented environmental understanding is common even among future teachers. Tang likewise notes that inadequate in-depth knowledge hinders climate change education implementation. Therefore, instructional leaders should prioritize curricular coherence and concept mapping, helping science teachers clearly distinguish the greenhouse effect, global warming, ozone depletion, radiation, and acid rain through model-based teaching, cross-topic comparison tasks, and supervised collaborative planning.

Theme 4: Leadership support must address not only knowledge, but also teacher confidence and instructional self-efficacy.

The findings imply that when teachers remain at a partially correct or functional understanding, they may hesitate to teach environmental science with full explanatory confidence. This is especially serious in science education, where teacher certainty shapes classroom discourse, examples, and students' trust in scientific explanations. The file itself concludes that professional development should not only address misconceptions but also strengthen teachers' confidence in teaching environmental science concepts effectively. Current literature strongly supports this reading. Tang found that teachers' willingness to implement climate change education is significantly influenced by attitudes, self-efficacy, and situational support, while cognitive knowledge shapes willingness indirectly through affective dimensions. Similarly, Christensen and Jerrim's cross-national study on professional learning communities reported that PLC participation is positively associated with several teacher outcomes, especially job satisfaction, while effects on self-efficacy and clarity of instruction vary across contexts. For instructional leaders, this means development support should include safe opportunities to rehearse explanations, receive feedback, and build efficacy, not merely attend content lectures. Demonstration teaching, peer observation, and guided reflection can help teachers convert uncertain knowledge into confident practice.

Theme 5: Effective instructional leadership support should be job-embedded, collaborative, and sustained.

The pattern of partial understanding across all four concepts suggests that short-term or purely lecture-based training may be insufficient. What teachers need is ongoing support embedded in their actual work. The strongest research evidence points in this direction. A systematic review by Ventista and Brown found that training, ongoing coaching, and collaborative continuous professional development are associated with positive student learning outcomes, especially when professional development is frequent and sustained over time. Powell and Bodur also found that teachers viewed online professional development as more meaningful when it was relevant, authentic, and connected to job-embedded practice; mere access to professional

development materials was inadequate. In the present findings, the issue is clearly not that teachers have never encountered these topics, but that their understanding remains incomplete. Hence, science department heads and principals should organize lesson study, coaching cycles, peer debriefing, microteaching on environmental science topics, and continuous content-focused LAC/PLC sessions. This kind of sustained support is more likely to reshape teacher understanding than isolated seminar attendance.

Theme 6: Instructional leadership should move from training delivery to a culture of inquiry, evidence use, and teacher-led improvement.

The findings point toward the need for a more transformative model of leadership support—one in which teachers are not passive recipients of training, but active inquirers into their own misconceptions and practice. Since the results show uneven understanding across concepts, instructional leaders can use these findings as school-level evidence for planning a responsive professional development agenda. Leadership literature emphasizes that professional learning opportunities, collaborative learning environments, instructional coaching, and supportive supervision are among the instructional leadership functions most strongly associated with teacher development. In He et al.'s study, "professional learning opportunities for teachers" emerged as the leadership dimension that most effectively supported professional development. This aligns with science-specific work by Cortes, who showed that a teacher-informed participatory action research guide supported science teachers' long-term development and enabled them to produce strong professional outputs through a four-year program. Therefore, instructional leadership development support for science teachers should include school-based action research, data-informed mentoring, and structured reflection on classroom misconceptions, so that teachers gradually become co-constructors of science improvement rather than mere attendees of professional development activities.

Synthesis

Taken together, the findings portray science teachers as possessing a usable but fragile conceptual foundation: stronger in greenhouse effect and radiation, weaker in acid rain and ozone depletion, and broadly characterized by partial rather than fully scientific understanding. In thematic terms, this means instructional leadership support should do six things: build from strengths, diagnose misconceptions, clarify conceptual boundaries, strengthen confidence, embed development in collaborative practice, and cultivate inquiry-oriented professional culture. Literature consistently supports this direction, showing that instructional leadership, sustained coaching, collaborative professional learning, and targeted climate-change-related training can improve teacher growth and instructional quality.

Instructional Leadership Development Support Framework for Strengthening Science Teachers' Conceptual Understanding of Environmental Issues

The emerging framework suggests that instructional leadership development support serves as the enabling force that shapes how science teachers improve their conceptual understanding of environmental issues. The findings show that teachers possess a moderate but uneven understanding, with stronger performance in the greenhouse effect and radiation, but weaker performance in acid rain and ozone depletion. This indicates that teachers do not entirely lack knowledge; rather, their scientific understanding is fragmented, often remaining at the levels of partially correct or functional understanding instead of reaching scientifically correct understanding.

In this framework, instructional leadership operates through four major support mechanisms: diagnostic leadership support, capacity-building support, collaborative instructional learning structures, and monitoring and feedback mechanisms. Diagnostic support begins with the use of assessment data to determine where teachers are strongest and where misconceptions persist. Capacity-building support then responds to these gaps through targeted training, concept clarification, and content enrichment. Collaborative learning structures such as Learning Action Cell sessions, peer coaching, and lesson study create spaces where teachers can process concepts together and refine their explanations. Monitoring and feedback mechanisms

ensure that leadership support is not episodic but continuous, allowing progress in conceptual understanding to be tracked and strengthened over time.

The central proposition of the framework is that when instructional leadership is responsive and sustained, teachers are more likely to move from partial, functional, or incorrect understanding toward scientifically correct understanding. This conceptual improvement is expected to lead to better instructional delivery, stronger confidence in teaching environmental science topics, and ultimately more accurate student learning. Thus, the framework positions instructional leadership not merely as administrative supervision, but as a developmental system that transforms teacher misconceptions into stronger science teaching competence.

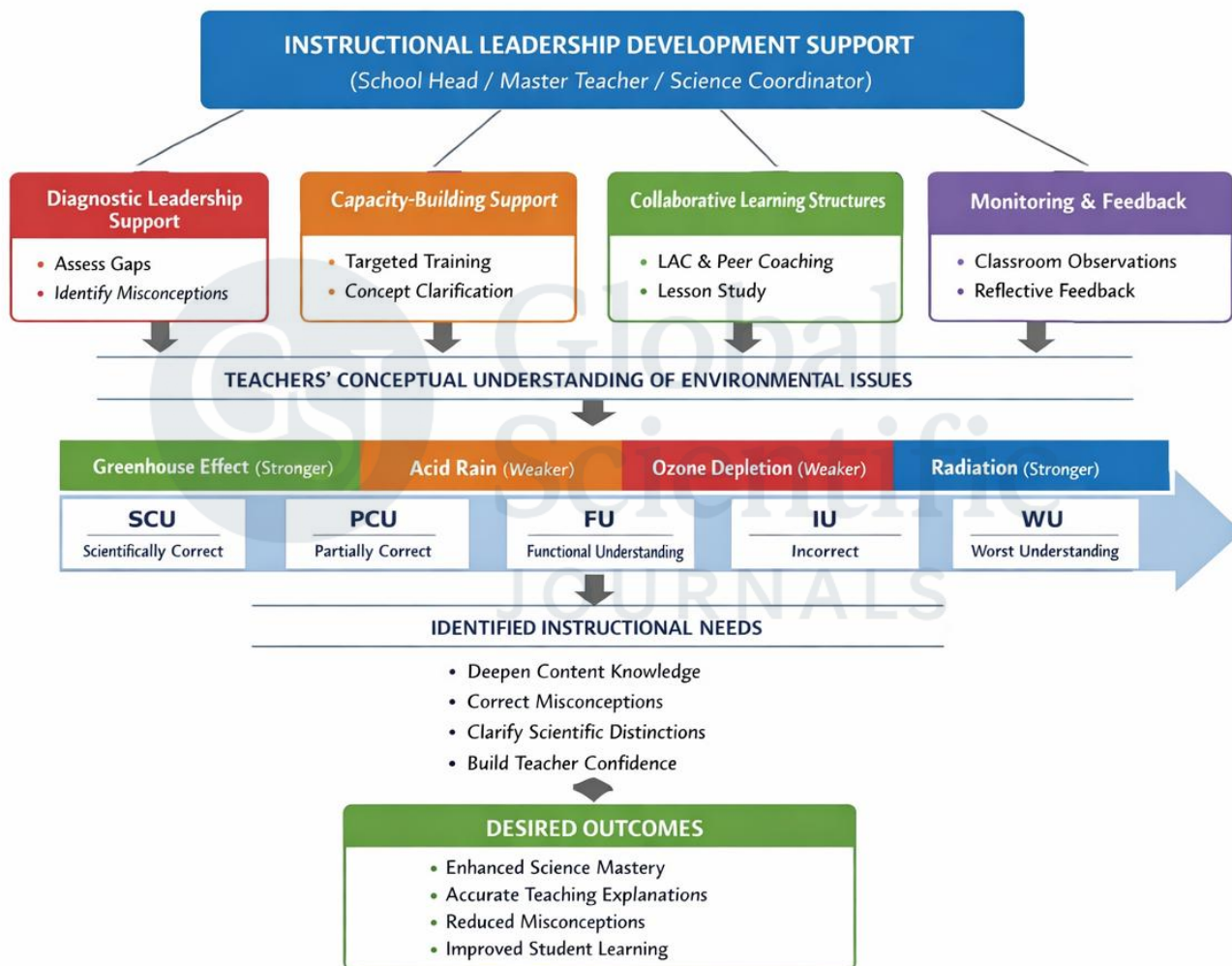


Figure 2. *Instructional Leadership Development Support Framework for Strengthening Science Teachers' Conceptual Understanding of Environmental Issues*

Summary of findings, Conclusions, and Recommendations

The summary, findings, conclusions, and recommendations of the study. It highlights the key results on science teachers' conceptual understanding of selected environmental issues and proposes instructional leadership development support to strengthen science teaching and professional growth.

Summary

This study determined the conceptual understanding of Junior High School science teachers on selected environmental issues as a basis for initiating instructional leadership development support. It focused on four environmental science concepts, namely greenhouse effect, acid rain, ozone depletion, and radiation. The study was conducted among fifty (50) Junior High School science teachers from selected public secondary schools in the Division of Surigao del Norte during School Year 2022–2023. It was framed from the need to strengthen science teachers' content knowledge and instructional competence through leadership-guided support mechanisms that are responsive to their actual conceptual needs.

The study employed a descriptive research design using a researcher-made multiple-choice test as the primary data-gathering instrument. The teacher-participants were selected through simple random sampling with proportionate allocation to ensure fair representation from the participating schools. The instrument was validated by experts and was used to assess the level of teachers' conceptual understanding across the four identified environmental issues. The data were analyzed using frequency and percentage to determine the distribution of teachers' levels of understanding, while conceptual analysis was used to formulate appropriate instructional leadership development support based on the observed patterns of understanding.

The study was anchored on the view that science teachers' conceptual understanding is essential to effective environmental science instruction. Since environmental concepts are often abstract, interconnected, and prone to misconceptions, teachers need sustained instructional support to deepen their scientific explanations and improve classroom delivery. Thus, the study sought not only to describe teachers' conceptual understanding but also to provide a basis for initiating instructional leadership development support, such as content-focused professional development, mentoring, coaching, Learning Action Cell sessions, lesson study, instructional materials development, and continuous monitoring and feedback.

Findings

The findings of the study are presented accordingly:

1. Findings revealed that the Junior High School science teachers demonstrated varying levels of understanding across the greenhouse effect, acid rain, ozone depletion, and radiation. The teachers showed stronger conceptual understanding in the areas of greenhouse effect and radiation, where most responses reflected scientifically correct or partially correct understanding. However, comparatively weaker understanding was observed in acid rain and ozone depletion, where more teachers demonstrated partial, functional, or incorrect understanding. This indicates that while the teachers possessed foundational knowledge of the selected environmental issues, some concepts still required clarification, enrichment, and correction of misconceptions.

2. The results indicated the need for targeted, evidence-based, and concept-specific support for science teachers. The proposed instructional leadership development support may include content-focused professional development, mentoring and coaching, Learning Action Cell sessions, lesson study, peer collaboration, instructional materials development, classroom observation, and continuous monitoring with feedback. These support mechanisms are intended to strengthen teachers' conceptual understanding, address identified gaps, improve instructional delivery, and sustain professional growth in environmental science education.

Conclusion

The following conclusions are made based on the findings of this study.

1. Junior High School science teachers possess foundational knowledge of the greenhouse effect, acid rain, ozone depletion, and radiation; however, their understanding is not consistently scientifically correct across all areas. Their stronger understanding of the greenhouse effect and radiation suggests existing conceptual strengths, while the weaker understanding of acid rain and ozone depletion indicates the need for further clarification, enrichment, and correction of misconceptions.
2. Science teachers need targeted, evidence-based, and concept-specific instructional support to strengthen their content knowledge and improve classroom delivery. Instructional leadership development support may therefore focus on professional development, mentoring, coaching, collaborative learning, instructional materials development, and continuous feedback to address teachers' conceptual gaps and sustain improvement in environmental science teaching.

Recommendation

Based on the findings of the study and the conclusion presented, the following recommendations are suggested.

1. Science Teachers may engage in continuous learning through seminars, webinars, and collaborative learning communities, reflect on teaching practices, seek feedback, and participate in capacity-building programs that address specific areas of conceptual misunderstanding in global warming, and may promote the inclusion of learner-centered, inquiry-based activities in science classes that encourage critical thinking and real-world application of global warming concepts.
2. Administrators, School Heads, and Division Supervisors may initiate and institutionalize regular in-service training programs focused on climate change topics, particularly on ozone depletion and acid rain, and provide mentoring and support systems for early-career teachers to strengthen their conceptual and instructional competencies.
3. Curriculum Developers may revise and enhance science curriculum content, modules, and instructional materials to address identified misconceptions and conceptual gaps among teachers, emphasizing accurate, updated, and contextualized information aligned with global climate education standards.
4. Policymakers may formulate policies that mandate targeted professional development in environmental and climate change education, allocate funding and resources to support capacity-building initiatives and curriculum integration at the school and division levels.
5. Researchers may conduct further studies exploring the effectiveness of various professional development models on improving teachers' conceptual understanding and classroom practice. Comparative studies across regions or education levels may also be pursued.

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