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Scientific Literacy–Oriented Practices, Pedagogical Orientations, and Instructional Leadership of Master Teachers in Science Education: Basis for Instructional Framework

Kristoffer Bryan V. Dandan
University of Perpetual Help System DALTA, Las Piñas City, Philippines
krisryan.bd@gmail.com

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ABSTRACT

Scientific literacy has become a critical educational goal in science education because people need to use scientific knowledge, evaluate evidence, and make good decisions in a society that changes quickly. Despite reforms that encourage teaching through inquiry and focusing on learners, many science classrooms show different orientations to teaching and leadership practices that can affect the development of scientific literacy. This study aimed to examine the pedagogical orientations, instructional leadership practices, and scientific literacy-oriented practices of Master Teachers in Science Education and to develop a practical framework based on the findings. This study utilized a convergent mixed-methods design involving Science Master Teachers from public elementary and secondary schools in Santa Rosa City Division in Laguna. Quantitative data were collected through structured surveys and analyzed using descriptive statistics, correlation, and regression analysis. Qualitative data were collected through answering written open-ended questions and analyzed using thematic analysis. Findings revealed that inquiry-based, constructivist, and learner-centered orientations were more strongly associated with scientific literacy-oriented practices than teacher-centered approaches. Instructional leadership practices, particularly coaching and mentoring, instructional supervision, curriculum support, and monitoring and feedback, were found to contribute significantly to the promotion of scientific literacy-oriented instruction. Qualitative findings further highlighted the importance of contextual support, collaborative leadership, and reflective teaching practices in enhancing science instruction. The study concludes that the integration of learner-centered pedagogical orientations and effective instructional leadership practices strengthens the implementation of scientific literacy-oriented teaching. The proposed Scientific Literacy-Oriented Instructional Framework may serve as a guide for Master Teachers, school leaders, and policymakers in improving science instruction and advancing quality science education.

Keywords: *Instructional leadership, Pedagogical Orientations, Scientific literacy*

INTRODUCTION

Scientific literacy refers to the capacity to address and evaluate the validity of science-based information, and it is becoming a general skill expected of every individual as opposed to being an expertise reserved for professional scientists. As a result of the rapid growth of science and technology in the 21st Century and the resultant emergence of global health crises, climate change, and digital transformation, it has become increasingly important for people to have the ability to analyze evidence, identify how things function scientifically, and

provide appropriate responses based upon their evaluation (OECD, 2023). Science education provides the most feasible means to create a scientifically literate public capable of providing informed responses to many science-based questions and concerns.

Although science education reform efforts continue to be implemented in the Philippines, local data indicate that Filipino students perform poorly when assessed using international standards for science literacy. For example, in PISA 2022, the Philippines ranked among the lowest-scoring countries in terms of science literacy, which received an average score of 356, whereas the OECD average was 485 (OECD, 2023). Studies conducted locally also demonstrate persistent shortcomings in the development of key science process skills such as measuring, inferring, and predicting by students across grade levels (Mirabueno et al., 2023; Villafranca et al., 2024). Collectively, these findings suggest that existing educational practices are ineffective in converting educational content into functioning scientific literacy.

At the local level, the Schools Division of Santa Rosa City, Laguna, continues to pursue initiatives aimed at improving learner achievement and strengthening the quality of science education. However, recent assessment data indicate continuing learning challenges among learners. In the 2025 National Achievement Test (NAT), the division recorded a five percent decrease in overall performance compared to the previous assessment cycle, reflecting the need for intensified instructional interventions and improved teaching practices. Moreover, classroom assessment results and competency analyses reveal that learners continue to experience difficulties in higher-order thinking skills, scientific inquiry, evidence-based reasoning, and the application of scientific concepts to real-world situations, which are among the competencies necessary for the development of scientific literacy. These local concerns highlight the importance of examining the pedagogical orientations of science teachers and the instructional leadership practices of master teachers to understand better how these factors contribute to the promotion of scientific literacy-oriented practices and the improvement of learner outcomes in the Schools Division of Santa Rosa City, Laguna.

While there is a growing literature base examining both teacher pedagogical orientations and instructional leadership separately, there appears to be little empirical work exploring the inter-relationship between these two constructs within the context of science education reform. Research indicates that pedagogical content knowledge and general instructional leadership each have a separate impact on students' development of scientific literacy. Additionally, emerging themes and trends in science education include integrating digital tools for science simulations and contextualizing learning experiences to reflect local community needs (Villafranca et al., 2024). However, critical questions remain related to how instructional leaders can best facilitate the relationship between teacher pedagogical orientations and student literacy outcomes, specifically when considering the contexts of resource-poor and culturally diverse settings. Therefore, this study seeks to address this gap by assessing the relationships between pedagogical orientations, instructional leadership practices, and scientific literacy. More specifically, this study assesses how master teachers think and teach; how they lead instruction; and how all three dimensions combine to affect the development of scientifically literate learners. A multidimensional methodology was selected so that a comprehensive understanding of the variables that predict successful science teaching and leadership could be generated.

Despite numerous educational reform efforts focused on improving science education by enhancing the scientific literacy of students, and despite a focus on developing the scientific literacy skills of students through inquiry-based learning, real-world applications of scientific knowledge, and critical thinking, many classrooms continue to utilize traditional and teacher-focused methods for delivering science content. The variability in teaching practices within classrooms also has an impact on the potential for developing and sustaining scientific literacy. Another factor impacting whether or not students develop scientifically literate behaviors is the type of instructional leadership provided by Master Teachers. There are also variations in how Master Teachers implement their instructional leadership roles, which can result in different interpretations of what constitutes the promotion of scientific literacy in the classroom. As such, both pedagogical orientation and the manner in which Master Teachers lead their peers regarding instructional practices related to scientific literacy will be examined as contributing to the development of scientifically literate behaviors.

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Therefore, it is necessary to conduct a systematic examination of the current teaching orientations and leadership practices of Master Teachers and investigate how these two factors correlate with each other and serve as predictors of promoting scientific literacy in the classroom. Further investigation of these factors could also inform the design of a responsive and evidence-based instructional framework that promotes student development of scientifically literate behaviors.

How do Master Teachers' pedagogical orientations and instructional leadership practices collectively influence scientific literacy–oriented practices, and how can the integration of quantitative results and qualitative insights inform the development of a scientific literacy–oriented instructional framework?

The study examined scientific literacy-oriented practices, pedagogical orientations, and instructional leadership practices of Master Teachers and used the integrated findings to develop a Scientific Literacy-Oriented Instructional Framework.

METHODS

Research Design and Locale

This research utilized a convergent mixed-methods research design to investigate pedagogical orientations, instructional leadership practices of master teachers, as well as their influence on scientific literacy–oriented practices. A convergent research design was suitable for this research since it allows for the simultaneous collection and analysis of quantitative and qualitative data. The ability to integrate findings from both strands into one comprehensive explanation of educational phenomena makes the convergent research design particularly useful for situations where both statistical trends and contextual explanations need to be utilized to provide an adequate explanation of relationships among variables.

This study took place in the Division of Santa Rosa, Laguna, Philippines. It focused specifically on Master Teachers who teach in public elementary and secondary schools under the supervision of the Department of Education (DepEd). City of Santa Rosa is a highly urbanized city in Laguna, which has one of the fastest-growing populations in the country; it is also home to an array of industries. Moreover, all the public secondary schools in the Division of Santa Rosa have adopted standardized curricula. A primary goal of this curriculum is to improve students' scientific literacy, critical thinking, and problem-solving abilities in science education.

Participants and Sampling

Master Teachers in Science Education were part of the subject population for this study. This includes those Master Teachers in Science Education who work at public elementary and secondary schools that fall under the jurisdiction of the School Division that was previously identified. Specifically, Master Teachers who hold positions from Master Teacher I through Master Teacher IV and are currently involved in providing instruction to students, mentoring other teachers, implementing curricula, and providing instructional supervision to others. Due to their role in promoting and supporting scientifically literate teaching practices, Master Teachers in Science Education is viewed as the best possible source of data for this study.

Based on records obtained from the Schools Division Office, the total population of Science Master Teachers in the division consists of twenty-one (21) Master Teachers. Given the manageable size and accessibility of the population, this study used a total population sampling technique (census method) wherein all twenty-one (21) Science Master Teachers are included as respondents in both the quantitative and qualitative strands of the study. With this type of sampling, there is no need to select a random sample of the population. A census is used because it allows for the inclusion of everyone in the population, therefore providing a true reflection of the population. This provides higher validity to the results of the study.

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Quantitative Strand

This study employed a quantitative research design in the first stage of a convergent mixed-methods approach. Since a descriptive-correlational-predictive design was suitable for investigating the relationship among Master Teachers' pedagogical orientations, instructional leadership practices, and their science education-oriented teaching practices, this design was fit for the purpose of assessing how much Master Teachers used these types of approaches and if they were predictive of one another.

Independent variables include pedagogical orientations and instructional leadership practices. Pedagogical orientations relate to the instructional philosophies and methods used by Master Teachers to promote science learning. The concept of pedagogical orientations was defined as having four sub-dimensions, including an inquiry-based orientation, a constructivist orientation, a teacher-centered orientation, and a student-centered orientation. Each of the above orientations was operationally defined through a structured Likert-scale questionnaire. A higher rating indicated a greater degree of orientation.

The instructional leadership practices of Master Teachers were determined through documentary analysis of their Individual Performance Commitment and Review Form (IPCRF). Composite scores were computed to determine the level of instructional leadership practices.

The dependent variable represents scientific literacy-oriented practices. Scientific literacy-oriented practices represent how well Master Teachers incorporate scientific literacy principles in their teaching practices. Examples of such practices include promoting students' engagement in inquiry-based learning; incorporating real-world scientific context; developing students' critical thinking/problem-solving skills; encouraging evidence-based reasoning and argumentation; and providing a STS perspective. As with the other two variables, this variable is measured using a Likert-scale instrument. However, when responding to questions related to scientific literacy-oriented instructional practices, higher ratings represent stronger implementations of such practices.

The questionnaire has a significant component that consists of a structured quantitative survey. The quantitative section uses a 4-point Likert Scale (1-Strongly Disagree and 4- Strongly Agree) for measuring the degree and scope of each construct.

The quantitative part of the questionnaire is divided into three parts related to the research variables. Section I addresses the Respondent’s Profile. Section II addresses the science literacy-oriented practices via five dimensions: promoting inquiry-based learning, integrating authentic scientific contexts, enhancing critical thinking and problem-solving abilities, using evidence-based arguments and reasoning, and incorporating STS perspectives. Each dimension includes five questions (25 total) to determine how science literacy is integrated in teaching practice.

Section III assesses the pedagogical orientations, and there are four dimensions to the orientation: inquiry-based orientation, constructivist orientation, teacher-centered orientation, and student-centered orientation. There are five questions for each dimension (20 questions total) to address instructional beliefs and classroom practices that show how Master Teachers promote learning.

The content validity of the instrument was established through expert review utilizing the Content Validity Index (CVI), which involved inviting a panel of 6 experts in Science Education, Educational Leadership, and Research Methodology to review the instrument. Each item on the instrument was evaluated by the experts based upon its relevance, clarity, coherence, and fit with the conceptualizations of Pedagogical Orientations, Instructional Leadership Practices, and Scientific Literacy-oriented Practices. The experts used a 5-point scale; i.e., 1=not satisfactory; 2=less satisfactory; 3=moderately satisfactory; 4= satisfactory; and 5=very satisfactory. An Item-level Content Validity Index (I-CVI) was calculated by dividing the number of experts who gave each item a rating of either 3 or 4 by the total number of raters. If an I-CVI score were 0.78 or better than 0.78, then the item would be deemed acceptable. Items that received an I-CVI score lower than 0.78 would be revised or deleted. Additionally, the Scale-Level Content Validity Index (S-CVI) was also computed to assess the overall validity of the instrument. All feedback from the experts regarding the instrument was very carefully studied and led to revisions concerning the wording of items, improvements in clarity, and enhancements in alignment with clearly identified variables and sub-dimensions.

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Reliability was established via a pilot test with a group of respondents with characteristics very similar to those in the targeted sample of this study; however, this group would not have been part of this study. The data collected during the pilot test were analyzed using Cronbach's alpha to assess the degree of internal consistency of the instrument. Reliability coefficients were calculated for each of the subscales: e.g., Pedagogical Orientations; Instructional Leadership Practices; Scientific Literacy-Oriented Practices; as well as for the entire instrument. Acceptable levels for Cronbach's alpha coefficients were set at 0.7 or greater for individual subscales and 0.8 or greater for excellent internal consistency. Any subscales failing to meet these thresholds were thoroughly examined and modified as needed to improve inter-item consistency.

Qualitative Strand and Integration

Qualitative data were gathered via written open-ended qualitative questionnaires completed by twenty-one (21) Master Teachers. The written responses were subjected to thematic analysis based on a structured approach to familiarize oneself with the data, develop preliminary coding, categorize coding, identify emergent themes, and refine those identified themes. ATLAS.ti was used to assist with organizing the qualitative data, assigning and managing code assignments, grouping similar response data together, and aiding the researcher in identifying repeated patterns of association among the responses of each participant.

In a systematic and structured approach consistent with the qualitative descriptive methodology of the Convergent Mixed-Methods Research Design, the analytical process was implemented. The qualitative data from the written open-ended responses received from the participants necessitated that the qualitative data analysis be performed.

Coding Once prepared, the next step in the qualitative data analysis was to code the qualitative data using ATLAS.ti. Initially, the researcher performed an open coding technique while reading and analyzing each participant's responses. As such, the researcher identified key words, phrases, or sentences that were significant to answering the research questions.

Through a review/refinement of the previously established coded data and categories using ATLAS. It was determined if these were representative of repeating patterns within the data. Themes were created from repeated ideas/key concepts reported by participants.

Quantitative and qualitative data were collected and analyzed separately, yet brought together for the purpose of understanding how Master Teachers' pedagogical orientations, instructional leadership practices, and scientific literacy-oriented practices are connected. A methodological tool called a data merging process was used to compare participants lived experience (qualitative) with data provided by numerical trends (quantitative). The goal of using a data merging process was to have each strand contribute equally to the answer of the central mixed-methods research question. Further, the merging of data contributed to the creation of an instructional framework for scientific literacy.

Data Analysis

The statistical treatment employed in this study allows the systematic evaluation of the quantitative responses made by participants during the collection process, enabling researchers to answer research questions through the application of relevant descriptive and inferential statistical methods. Quantitative data collected with a researcher-developed survey instrument were encoded, organized, and analyzed utilizing statistical software, including SPSS.

In interpreting mean scores, a descriptive scale based upon the 4-point Likert Scale was utilized (3.50–4.00=Very High/Strongly Agree; 2.50–3.49=High/Agree; 1.50–2.49 =Low/Disagree; 1.00–1.49=Very Low/Strongly Disagree), allowing for easy and uniform interpretation of levels of each variable.

For inferential statistical analysis, the Pearson Product-Moment correlation coefficient (r) was used to examine statistically significant relationships between variables. In particular, the study examined the relationship between pedagogical orientation and scientific literacy-oriented practice, instructional leadership practices and scientific literacy-oriented practices, and pedagogical orientation and instructional leadership practices.

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Further, multiple linear regression analysis was employed to determine whether pedagogical orientations and instructional leadership practices can be used to significantly predict scientific literacy-oriented practices. Regression analysis allowed identification of the Extent to which each independent variable contributed to the dependent variable as well as their predictive value.

Ethical Considerations

This research complies with standard ethics in research to protect participants' rights, safety, dignity, and privacy throughout all aspects of data collection and analysis. Ethics were applied in both quantitative and qualitative aspects of this study, especially when it comes to informed consent, confidentiality and/or anonymity, volunteerism, compliance with Republic Act No. 10173 (Data Privacy Act of 2012), and the appropriate utilization of AI-assisted research tools.

Confidentiality and/or anonymity have been ensured by the researchers so that the identity of respondents and personal information cannot be identified by anyone who may obtain a copy of the data. Respondents' names and other identifiers have not been recorded in any section of the data analysis or report. Pseudonyms or codes have been given to each respondent to protect their identity. All forms of data collected, surveys, and written transcripts with open-ended questions are stored securely by the researcher. The researcher has complete control over who accesses and analyzes the data, and it is only accessible for academic/research purposes.

RESULTS

Quantitative Findings

The quantitative results showed very high levels of scientific literacy-oriented practices and pedagogical orientations, while instructional leadership practices were rated outstanding.

Variable	Overall Mean	SD	Interpretation
Scientific Literacy-Oriented Practices	3.61	0.49	Very High
Pedagogical Orientations	3.51	0.56	Very High
Instructional Leadership Practices	4.58	0.38	Outstanding

Scientific literacy-oriented practices were Very High overall (M = 3.61). Inquiry-based (M = 3.59), constructivist (M = 3.63), and student-centered (M = 3.58) orientations were Very High, while teacher-centered orientation was High (M = 3.26). Pedagogical orientations had an overall mean of 3.51. Instructional leadership practices were Outstanding overall (M = 4.58).

Relationships and Predictive Influence

Relationship	r	p
Pedagogical Orientations ↔ Scientific Literacy-Oriented Practices	0.584	0.005
Pedagogical Orientations ↔ Instructional Leadership	0.716	< .001
Scientific Literacy-Oriented Practices ↔ Instructional Leadership	0.817	< .001

All three relationships were statistically significant. The strongest relationship was between scientific literacy-oriented practices and instructional leadership ($r = 0.817$, $p < .001$). Multiple regression showed that instructional leadership significantly predicted scientific literacy-oriented practices ($\beta = 0.817$, $p < .001$), whereas pedagogical orientations did not provide a unique significant contribution when both variables were examined together. The overall model was significant ($R = 0.817$, $R^2 = 0.667$, adjusted $R^2 = 0.630$, $F = 18.003$, $p < .001$).

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Qualitative Findings

Written open-ended responses from twenty-one (21) Master Teachers generated five interrelated themes:

1. Learner-Centered and Inquiry-Based Pedagogical Orientation as the Foundation of Scientific Literacy
2. Instructional Leadership Through Coaching, Mentoring, and Professional Learning
3. Reflective Practice and Collaborative Professional Culture
4. Adaptive and Supportive Instructional Leadership in Addressing Teachers' Diverse Professional Needs
5. Innovation, Resourcefulness, and Continuous Professional Growth as Enablers of Sustainable Scientific Literacy

The qualitative findings emphasized active inquiry, learner engagement, critical thinking, contextualized teaching, coaching and mentoring, reflective practice, collaboration, adaptive support, and continuous professional development. These themes provided contextual support for the quantitative findings and informed the proposed framework.

Integrated Findings and Framework

Integration of the quantitative and qualitative findings produced five interrelated dimensions of the Scientific Literacy-Oriented Instructional Framework: Learner-Centered and Inquiry-Based Pedagogy; Coaching and Mentoring Leadership; Reflective and Collaborative Professional Learning; Adaptive and Supportive Leadership; and Innovation and Continuous Professional Growth.

DISCUSSION

Findings from this study showed that Master Teachers employed an extremely high degree of Scientific Literacy-Oriented Practices. In particular, they often connected what was being taught to the real world; used inquiry-based methods for instruction; promoted student development of higher-order thinking skills such as critical thinking/problem solving; utilized evidence-based reasoning; and incorporated Science, Technology, and Society (STS) perspectives into their teaching. This indicates that Master Teachers are typically using the same type of scientific literacy instructional methodologies that have been recommended by contemporary theorists of scientific literacy.

While this study indicates that Master Teachers have an extremely high emphasis on inquiry-based teaching, constructivist philosophies of teaching and learning, as well as a high degree of student-centeredness, there is a significant amount of teacher-centeredness evident in these teachers' orientations to teaching and learning. Overall, the results indicate that most Master Teachers appear to be utilizing student-centered approaches to teaching and learning, emphasizing students' active participation in their own learning experiences; inquiry; peer-to-peer collaboration; and the active process of constructing new knowledge.

The research showed that Master Teachers were found to have a significant impact on improving student outcomes through their instructional leadership. As such, they received an exceptional rating for each domain of the study: Content knowledge and Pedagogy; Learning Environment; Diversity of Learners; Curriculum and Planning; Assessment and Reporting; Professional Growth and Development. These data suggest that Master Teachers exhibit strong instructional leadership at the school level.

Pedagogical orientation was significantly related to the use of science literacy- oriented practices in the classroom. The results confirm the theoretical framework supported in the literature review: that pedagogy directly influences a teacher's use of instructional strategies associated with developing science literacy.

Strong evidence was found to support that there is a very strong association between Pedagogical Orientation and Instructional Leadership Practices; as such, Master Teachers will be more likely to engage in Instructional Leadership when their Pedagogical Orientation leans toward being Learner-Centered.

The strongest relationship was between instructional leadership practices and scientific literacy-oriented practices. Therefore, we can infer that the functions of the school leader will be most important to promote and sustain science teaching practices that are supportive of students' attainment of scientific literacy.

Regression analysis showed that instructional leadership practices strongly predict practices oriented toward scientific literacy but pedagogical orientations do not add a unique significant contribution when both are looked at together at the same time.

Therefore, the convergence of both quantitative and qualitative data resulted in five related dimensions, which will help create the framework for Scientific Literacy Oriented Instruction: Learner-Centered and Inquiry-Based Pedagogy, Coaching and Mentoring Leadership, Reflective and Collaborative Professional Development, Adaptive and Supportive Leadership, and Innovation and Ongoing Professional Growth. In summary, this study has illustrated that Scientific Literacy Oriented Instruction cannot simply occur as a result of pedagogy alone, but must occur as a result of collaborative efforts between teachers and school leaders who believe in continuous professional growth and development. Therefore, this study provided empirical evidence supporting a framework for integrating pedagogy and leadership as complementary processes to support Science Education.

The proposed framework includes five interrelated dimensions: Learner-Centered and Inquiry-Based Pedagogy, Coaching and Mentoring Leadership, Reflective and Collaborative Professional Development, Adaptive and Supportive Leadership, and Innovation and Continuous Professional Growth. Collectively, these dimensions will help strengthen instructional quality and foster the sustainability of scientific literacy-oriented practices. Additionally, the proposed framework identifies instructional leadership as the critical element that enables the transformation of teachers' pedagogical beliefs into effective instructional practices. A result that supports the regression analysis, where instructional leadership proved to be the most powerful predictor of the use of scientific literacy-oriented practices.

Limitations

There are several restrictions that need to be taken into account when interpreting the results from this study. Firstly, the study is based on the Master Teachers in Science Education from the Schools Division of Santa Rosa City, Laguna. In addition to providing useful insights into their pedagogical orientations, instructional leadership, and scientific literacy-oriented teaching practices, the results cannot possibly be fully applied to other divisions, educational settings, and/or to teachers from other areas of the Philippines with different institutional conditions and professional experience. Therefore, consideration needs to be given to the specific context of this study when using these results outside the framework of this study.

Secondly, the study mainly used survey responses (self-reports) and qualitative descriptions from the participant's perspective. Although efforts have been made to validate instruments for reliability and trustworthiness, self-reports will be subject to bias from individual perception, social desirability, or varying levels of interpretation of the survey questions. Furthermore, qualitative findings describe the participants' experiences and viewpoints at the time of data collection and cannot represent all aspects of an instructional practice and/or leadership behaviors.

Thirdly, the quantitative part of the study has a descriptive-correlational-predictive structure; therefore, it is possible to analyze correlations between variables and predictive factors amongst variables, but no causal relationship is established. Consequently, even though significant correlations and predictions existed, they cannot be taken as irrefutable proof of causality. Lastly, although a convergent mixed-methods approach allowed us to develop a richer and complementary body of evidence, our focus was on Master Teachers only. We did not collect information from students, school administrators, parents, policy makers, etc., to develop a better insight into what could be involved in developing science literacy through education.

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CONCLUSION

1. A master teacher has a high level of ability to promote scientific literacy; this conclusion was derived from the fact that they have consistently used inquiry-based, contextualized, and learner-centered methods in their instruction. As such, scientific literacy-oriented instruction is a practice that has been established and is being implemented successfully in the classrooms of the teachers studied.

4. Pedagogical Orientations, Instructional Leadership Practices, and Scientific Literacy-Oriented Instructional Practices are connected dimensions of a practitioner's work. There will typically be positive movement or change in one dimension, and there will typically be positive changes in the other two dimensions.

5. Instructional Leadership plays a key role in supporting the implementation of Scientific Literacy-Oriented Instructional Practices. Although Pedagogical Orientation provides the philosophical basis for effective science teaching, it is the provision of Organizational and Professional Support provided by Instructional Leadership that enables a teacher to transform their philosophy into a sustainable instructional practice.

6. The data collected during this investigation provide empirical evidence that refines the conceptual framework previously developed for this study. Specifically, the results indicate that Instructional Leadership has a greater direct impact on the degree to which Scientific Literacy-Oriented Instructional Practices are implemented than do Pedagogical Orientations when examining both variables together.

7. Scientific Literacy-Oriented Instruction is best supported when learner-centered pedagogy, instructional leadership, collaborative professional learning, adaptive support systems, and ongoing professional development occur together.

8. The proposed Scientific Literacy-Oriented Instructional Framework represents an empirically grounded and contextually relevant model for enhancing science education and preparing scientifically literate learners in the Philippines.

Recommendations

1. Future research should replicate this study in other divisions, regions, or educational settings to see if orientations towards pedagogy, leadership for instruction, and practices oriented towards scientific literacy are consistent across different contexts.

4. Future research should use experimental or quasi-experimental designs to evaluate the effectiveness of specific leadership interventions, mentoring programs, or professional development initiatives aimed at improving practices oriented towards scientific literacy.

2. Improvement of Professional Practices. School Leaders and Master Teachers should engage in structured mentoring programs; Learning Action Cells; Collaborative Lesson Planning; and Coaching Initiatives for improving student-centered, inquiry-based instruction.

4. Institutional Capacity Development. Schools and Divisions should provide ongoing professional development focusing on instructional leadership, scientific literacy, inquiry-based teaching, and innovative instructional practices.

5. Use of Proposed Scientific Literacy-Oriented Instructional Framework. School Administrators can utilize the Proposed Scientific Literacy Oriented Instructional Framework as a model for developing programs for supervising teachers, developing teachers through professional development initiatives, and school-wide improvement programs.

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