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Reframing Senior High Science Pedagogy for Curriculum Strengthening and Inquiry Readiness

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ABSTRACT

This study explored how reframed Senior High School Science pedagogy under the strengthened curriculum related to learner inquiry readiness in Enrile, Cagayan. A cross-sectional multisource explanatory design with a pedagogical alignment component was employed among 10 Senior High School Science teachers and 100 Grade 11 learners. Data were gathered using validated teacher and learner instruments measuring curriculum coherence, inquiry facilitation, evidence-centered assessment, adaptive scaffolding, and inquiry readiness. The instruments demonstrated strong internal consistency, with Cronbach's alpha coefficients of 0.931 and 0.918. Descriptive statistics, a pedagogical alignment index, and Bayesian multilevel regression were used in the analysis. Results showed that teachers reported stronger implementation of reframed Science pedagogy than learners experienced, with the widest discrepancy occurring in adaptive scaffolding. Learners demonstrated generally high inquiry readiness, although question formulation and evidence handling remained comparatively weaker. Bayesian estimates showed that learner-experienced Science pedagogy positively predicted inquiry readiness ($\beta = 0.47$), while larger teacher-learner pedagogical gaps were associated with lower readiness ($\beta = -0.26$). The model explained 46% of the variation in inquiry readiness, with 13% attributable to classroom-level differences. The findings indicate that curriculum strengthening becomes more meaningful when inquiry-oriented practices are consistently enacted and recognized by learners. Strengthening learner-generated questioning, evidence use, adaptive support, and classroom alignment is therefore essential for advancing inquiry readiness in Senior High School Science.

Keywords: *adaptive scaffolding, curriculum strengthening, inquiry readiness, pedagogical alignment, science pedagogy, Senior High School*

INTRODUCTION

Science education at the senior high school level carries a responsibility beyond helping learners remember concepts and formulas. It should enable them to interpret evidence, explain phenomena, question claims, and make reasoned decisions from scientific information. This remains a pressing concern in Philippine education. Results from PISA 2022 showed that only 23% of Filipino students reached at least Level 2 proficiency in science, compared with the OECD average of 76%, while almost no Filipino participants reached the highest proficiency levels. These results point to the need for classroom experiences that develop scientific reasoning alongside content knowledge (Organisation for Economic Co-operation and Development [OECD], 2023).

The Strengthened Senior High School Curriculum provides an important opportunity to address this need. Beginning School Year 2026–2027, the Department of Education directed the full implementation of the strengthened curriculum for incoming Grade 11 learners. The reform introduces structural, instructional, and content changes intended to promote stronger mastery of foundational competencies, greater learner choice, and improved preparation for higher education, employment, and other postsecondary pathways (Department of Education [DepEd], 2026). For Science teachers, these changes call for more than adjustment to subject offerings. They require careful consideration of how scientific ideas are taught, explored, assessed, and connected with the ability of learners to investigate problems and construct evidence-based explanations.

Inquiry offers a strong pedagogical basis for this shift because it places learners in an active process of asking questions, examining evidence, testing explanations, and communicating conclusions. Its effectiveness, however, depends greatly on the quality of instructional support provided by the teacher. A meta-analysis of 72 studies found that appropriately guided inquiry produced positive effects on learning activities, performance, and learning outcomes, showing that inquiry is most productive when learner independence is supported by purposeful teacher guidance (Lazonder & Harmsen, 2016). This distinction is especially important in senior high school, where learners are expected to handle increasingly complex scientific concepts without being left to navigate scientific investigation without sufficient scaffolding.

Evidence from secondary science education further shows that inquiry-based teaching can strengthen research skills, scientific reasoning, and the construction of scientific knowledge. At the same time, successful implementation depends on teachers' understanding of inquiry, their selection of suitable instructional strategies, and their ability to manage different levels of learner participation (Urdanivia Alarcon et al., 2023). Teacher readiness therefore becomes closely tied to learner inquiry readiness. Curriculum expectations may provide direction, but the quality of classroom enactment determines whether learners actually gain opportunities to reason, investigate, interpret findings, and defend conclusions.

Teacher preparation for inquiry also deserves attention because knowing science and knowing how to teach science through inquiry are related but distinct capacities. A systematic review of 142 empirical studies reported favorable outcomes of inquiry-based science education for science understanding, teaching competence, attitudes, and self-efficacy, while also identifying difficulties in transferring inquiry-oriented preparation into actual classroom practice (Strat et al., 2024). These findings make it important to examine curriculum strengthening not only through prescribed competencies but through the teaching practices that learners actually experience.

This study seeks to determine how Science pedagogy is being shaped under the strengthened Senior High School Curriculum among teachers and learners in Enrile, Cagayan. It gives particular attention to the alignment of instructional practices with curriculum expectations and to the readiness of learners to participate meaningfully in scientific inquiry. By examining these areas together, the study may provide evidence for refining classroom practices, strengthening teacher support, and promoting Science learning that develops both conceptual understanding and the capacity to think and work scientifically.

Literature Review

Curriculum Coherence and Strengthened Science Learning

Curriculum strengthening in science requires more than the addition or rearrangement of competencies. It depends on whether concepts, learning activities, and expected performances are connected in ways that allow learners to build understanding across lessons. Roehrig et al. (2021) found that coherent STEM curricula deliberately connect disciplinary concepts with authentic problems and learning tasks rather than presenting scientific knowledge as isolated content. Kelley and Knowles (2016) similarly argued that effective STEM learning brings scientific inquiry, technological literacy, engineering design, and mathematical thinking together through meaningful situations. For Senior High School Science, this suggests that curriculum strengthening should be reflected in the actual organization of instruction, where concepts are linked with investigation, application, and problem solving. Such coherence can help learners see Science as a connected process of understanding phenomena rather than a sequence of topics to be completed.

Inquiry-Oriented Science Pedagogy

Inquiry-oriented pedagogy places scientific questions, evidence, explanation, and learner reasoning at the center of classroom activity. Dobber et al. (2017), based on a review of 186 studies, identified teacher strategies that support inquiry through conceptual guidance, thinking skills, inquiry discourse, collaboration, and opportunities for greater learner direction. Inquiry, however, should not be treated as an automatic replacement for all forms of direct teaching. Oliver et al. (2021) found that the relationship between inquiry instruction and scientific literacy varies according to how inquiry practices are implemented, while adaptive and teacher-directed approaches can also contribute positively to learning. These findings favor a balanced pedagogy in which teachers provide appropriate structure while gradually allowing learners to formulate questions, interpret evidence, test ideas, and explain scientific findings. Such balance is particularly relevant when reframing Senior High School Science instruction for stronger inquiry participation.

Teacher Capacity for Inquiry Enactment

The success of inquiry-centered curriculum reform is closely tied to the capability and confidence of science teachers who translate curriculum expectations into classroom practice. Kaya et al. (2021) found a connection between secondary Science teachers' self-efficacy and their implementation of essential inquiry features, with teachers showing greater confidence in teacher-centered inquiry than in more student-directed forms. Their content knowledge, pedagogical knowledge, and teaching experience also influenced inquiry implementation. Practical conditions can further shape this capacity. Fitzgerald et al. (2019) identified limited instructional time, insufficient professional development, unclear models of inquiry, and inadequate teaching resources as major barriers to inquiry-based Science teaching. These findings indicate that reframing Science pedagogy requires attention not only to what teachers are expected to teach but also to their readiness to facilitate investigation, manage learner autonomy, provide appropriate scaffolding, and work within the realities of the school environment.

Learner Inquiry Readiness and Scientific Reasoning

Inquiry readiness involves the capacity of learners to engage productively with questions, evidence, explanations, and decisions that require scientific reasoning. Bao and Koenig (2019) emphasized scientific reasoning as a central educational outcome associated with critical thinking, problem solving, decision making, and the transfer of knowledge across scientific situations. Learners therefore need repeated opportunities to move beyond receiving information toward examining how scientific conclusions are constructed and justified. Evidence from secondary classrooms also demonstrates that these abilities can be developed through purposeful pedagogy. Songsil et al. (2019) found that Grade 10 learners exposed to revised argument-driven inquiry improved their scientific argumentation skills and achieved stronger post-instruction performance than learners taught through a conventional approach. Inquiry readiness can thus be viewed as a developable capacity shaped by classroom experiences, particularly those that require learners to examine evidence, articulate claims, justify conclusions, and participate actively in scientific discourse.

METHODS

Research Design

The study employed a cross-sectional multisource explanatory design with a pedagogical alignment component. This design allowed evidence from Senior High School Science teachers and learners to be examined within the same instructional structure. Teacher responses captured the extent to which Science pedagogy had been reframed in relation to curriculum coherence, inquiry facilitation, evidence-centered assessment, and adaptive scaffolding, while learner responses measured their experienced Science instruction and inquiry readiness. The multisource structure also permitted comparison between teacher-reported instructional practices and learner-perceived classroom experiences. Rather than limiting the analysis to description and simple correlation, the design examined whether stronger pedagogical alignment was associated with greater readiness to formulate questions, work with evidence, construct explanations, and participate in scientific inquiry.

Research Locale

The investigation was conducted in the secondary education setting of Enrile, Cagayan. The locale was selected because Senior High School education was offered within the municipality and Grade 11 learners were already covered by the Strengthened Senior High School Curriculum, which included General Science as a core learning area. The setting provided an appropriate site for examining how curriculum changes were translated into Science classroom practices and how learners responded to inquiry-oriented expectations.

Participants and Sampling Technique

The participants consisted of 10 Senior High School Science teachers and 100 Grade 11 learners, for a total of 110 respondents. The teachers were those directly handling General Science or Science-related learning experiences under the strengthened curriculum and were included through total enumeration of the eligible teaching group available during data collection. For the learner component, proportional systematic random sampling was applied to Grade 11 learners enrolled in classes handled by the participating Science teachers. The sampling interval was determined from the eligible class lists, after which learners were selected using a randomly determined starting point. This procedure maintained representation across participating classes while keeping the learner sample proportionate and manageable.

Research Instrument

Two coordinated researcher-developed instruments were used. The Science Pedagogical Reframing Scale for Teachers contained 28 statements organized under curriculum coherence, inquiry facilitation, evidence-centered assessment, and adaptive scaffolding. The Science Inquiry Readiness Scale for Learners contained 24 statements covering question formulation, evidence handling, scientific reasoning and explanation, and inquiry participation. A parallel set of learner items also captured their experience of inquiry-oriented teaching so that teacher and learner perceptions could be compared.

The instruments underwent content validation by five specialists in Science education, curriculum studies, educational measurement, and Senior High School instruction. The item-level Content Validity Index ranged from 0.80 to 1.00, while the Scale Content Validity Index based on the average method was 0.96 for the teacher instrument and 0.95 for the learner instrument. Minor revisions were made to six statements to improve precision and reduce overlapping meanings.

Pilot testing was conducted among respondents outside the research locale who possessed characteristics comparable with those of the intended participants. The pilot group consisted of 20 Senior High School Science teachers and 30 Senior High School learners. Reliability analysis produced a Cronbach's alpha of 0.931 for the teacher scale and 0.918 for the learner scale. Dimension-level alpha coefficients ranged from 0.842 to 0.907, indicating strong internal consistency across the measured constructs. Corrected item-total correlations ranged from 0.417 to 0.781, and no item deletion produced a meaningful improvement in the overall reliability coefficient. The instruments were consequently retained in their final validated form for the main data collection.

Data Gathering

Permission to conduct the research was secured from the appropriate education authorities and school administrators before data collection. The researcher coordinated with designated personnel to identify eligible Science teachers and Grade 11 learners without obtaining unnecessary personal information. Teachers completed the instrument individually, while learner questionnaires were administered during an agreed class period under standardized instructions. Coded classroom identifiers were used to connect teacher responses with the corresponding learner group without recording respondent names. Completed forms were checked for completeness, encoded into a secured dataset, and subjected to data screening before statistical analysis.

Data Analysis

The data were analyzed using a Bayesian multilevel alignment model, which was selected because learner responses were naturally grouped within science classrooms and because the approach permitted estimation beyond conventional significance testing. Means, standard deviations, and composite domain scores were first obtained to describe pedagogical reframing and inquiry readiness. Teacher-reported pedagogy and the corresponding classroom-level learner ratings were standardized, and their absolute differences were used to derive a pedagogical alignment index, with smaller discrepancies indicating closer teacher-learner agreement.

Learner inquiry readiness was then examined through Bayesian hierarchical regression, with learner-experienced pedagogy and pedagogical alignment entered as predictors and classroom membership treated as a random intercept. Standardized regression estimates, 95% credible intervals, posterior probabilities, intraclass correlation coefficients, and Bayesian R^2 were reported. Weakly informative priors were applied to stabilize estimation given the compact number of teacher clusters. This approach allowed the analysis to determine not only whether Science pedagogy was related to inquiry readiness, but also whether closer agreement between intended teaching practices and learners' actual classroom experiences corresponded with stronger inquiry readiness.

Ethical Consideration

The study observed voluntary participation, informed consent, learner assent and parental consent where required, confidentiality, and the right to withdraw without penalty. No personally identifying information was included in the analytic dataset, coded responses were stored securely, and collected information was used solely for the stated research purposes. Participation or nonparticipation had no bearing on learners' grades or teachers' professional evaluation.

RESULTS AND DISCUSSION

Table 1. *Senior High School Science Pedagogy as Reported by Teachers and Experienced by Learners*

Pedagogical Dimension	Teacher Mean	SD	Learner Mean	SD	Mean Difference
Curriculum Coherence	4.31	0.39	3.86	0.55	0.45
Inquiry Facilitation	4.18	0.43	3.61	0.61	0.57
Evidence-Centered Assessment	3.87	0.51	3.42	0.64	0.45
Adaptive Scaffolding	4.24	0.41	3.55	0.60	0.69
Overall	4.15	0.44	3.61	0.60	0.54

Pedagogy, with an overall mean of 4.15. Curriculum coherence received the highest teacher rating at 4.31, suggesting that teachers generally connected competencies, activities, and learning outcomes under the strengthened curriculum. Learners, however, reported a lower overall experience of these practices at 3.61. The widest difference occurred in adaptive scaffolding, where teachers reported a mean of 4.24 while learners recorded 3.55, producing a gap of 0.69. This indicates that teachers believed they were adjusting explanations, questioning strategies, and learning support more consistently than learners actually experienced them. Inquiry facilitation also showed a visible difference of 0.57. The pattern suggests that curriculum strengthening had influenced instructional intentions, but classroom enactment remained uneven from the learners' perspective. Evidence-centered assessment received the lowest ratings from both groups, indicating that tasks requiring learners to justify claims, interpret data, or defend conclusions were less consistently embedded than conceptual teaching and lesson organization.

Table 2. *Level of Learner Inquiry Readiness*

Inquiry Readiness Dimension	Mean	SD	Interpretation
Question Formulation	3.31	0.67	Moderate
Evidence Handling	3.48	0.63	Moderate
Scientific Reasoning and Explanation	3.67	0.59	High
Inquiry Participation	3.74	0.61	High
Overall Inquiry Readiness	3.55	0.63	High

Table 2 shows that learner inquiry readiness reached an overall mean of 3.55, indicating that learners generally possessed the foundation needed to participate in inquiry-oriented Science learning. The strongest area was inquiry participation at 3.74, followed by scientific reasoning and explanation at 3.67. These findings suggest that learners were relatively comfortable participating in investigative activities and explaining scientific ideas once a task had been structured for them. A different pattern appeared in question formulation, which obtained the lowest mean of 3.31. Evidence handling also remained moderate at 3.48. The results reveal an important instructional concern. Learners appeared more prepared to respond to teacher-initiated investigations than to initiate inquiry independently. They could participate, interpret guided activities, and articulate explanations, yet they showed weaker readiness in generating investigable questions and determining how evidence should be selected or used. This suggests that inquiry opportunities were present, but learner independence in the earlier stages of scientific investigation remained limited.

Table 3. *Pedagogical Alignment Between Teacher-Reported and Learner-Experienced Science Instruction*

Dimension	Standardized Alignment Gap	Rank	Alignment Interpretation
Curriculum Coherence	0.34	4	Strong
Evidence-Centered Assessment	0.39	3	Strong
Inquiry Facilitation	0.48	2	Moderate
Adaptive Scaffolding	0.56	1	Moderate
Overall Alignment Gap	0.44		Moderate Alignment

Note. Smaller standardized gaps indicate closer teacher-learner alignment.

Table 3 indicates an overall standardized alignment gap of 0.44, reflecting moderate correspondence between what teachers reported doing and what learners experienced in Science classrooms. Curriculum coherence showed the closest agreement with a gap of 0.34. This means that curriculum sequencing and lesson organization were comparatively visible to learners. In contrast, adaptive scaffolding produced the largest gap at 0.56, followed by inquiry facilitation at 0.48. These differences suggest that some pedagogical practices that teachers considered embedded in their instruction were not experienced with the same consistency by learners. The finding is significant because curriculum reform depends not only on planned instructional practices but also on whether those practices become observable and meaningful learning experiences. The moderate alignment therefore points to a translation problem between instructional intention and classroom experience. Reframing Science pedagogy appeared to be underway, but its enactment had not yet become equally strong across classrooms and instructional dimensions.

Table 4. *Bayesian Multilevel Model Predicting Learner Inquiry Readiness*

Predictor	Standardized Estimate (β)	Posterior SD	95% Credible Interval	Posterior Probability	Interpretation
Learner-Experienced Science Pedagogy	0.47	0.09	0.29 to 0.64	0.999	Positive association

Pedagogical Alignment Gap	-0.26	0.10	-0.45 to -0.07	0.994	Negative association
Classroom Random Intercept	0.18	0.07	0.07 to 0.33		Meaningful classroom variation

Model Indicator	Value
Intraclass Correlation Coefficient	0.13
Bayesian R^2	0.46
Residual SD	0.54
Effective Sample Size	2,684
R-hat	1.00

Table 4 presents the Bayesian multilevel estimates for learner inquiry readiness. Learner-experienced Science pedagogy emerged as the strongest predictor, with a standardized estimate of $\beta = 0.47$ and a 95% credible interval from 0.29 to 0.64. The posterior probability of 0.999 indicated very strong evidence that more consistently experienced inquiry-oriented pedagogy was associated with stronger learner inquiry readiness. In practical terms, learners who more frequently experienced coherent instruction, inquiry facilitation, evidence-based assessment, and instructional scaffolding also tended to demonstrate stronger readiness for scientific inquiry.

The pedagogical alignment gap showed a negative estimate of $\beta = -0.26$, with the credible interval remaining below zero. This means that larger differences between teacher-reported practices and learner-experienced instruction were associated with lower inquiry readiness. The finding strengthens the argument that instructional intention alone was insufficient. What mattered was the degree to which intended pedagogy was actually experienced by learners.

The intraclass correlation coefficient of 0.13 further indicated that 13% of the variation in inquiry readiness was attributable to differences among Science classroom groups. This justified the use of a multilevel model because learner responses were not completely independent of the classrooms in which instruction occurred. The Bayesian R^2 of 0.46 showed that the model accounted for approximately 46% of the variation in learner inquiry readiness. Convergence diagnostics were also satisfactory, with an R-hat value of 1.00 and adequate effective sample size.

Table 5. *Posterior Estimates of Inquiry Readiness Across Levels of Pedagogical Experience and Alignment*

Classroom Condition	Estimated Inquiry Readiness	95% Credible Interval
Strong Pedagogy, Small Alignment Gap	4.08	3.87 to 4.28
Strong Pedagogy, Moderate Alignment Gap	3.78	3.57 to 3.99
Moderate Pedagogy, Moderate Alignment Gap	3.49	3.29 to 3.69
Moderate Pedagogy, Large Alignment Gap	3.18	2.94 to 3.41

Table 5 illustrates the combined instructional meaning of the Bayesian estimates. Learners exposed to strong Science pedagogy with a small teacher-learner alignment gap had the highest predicted inquiry readiness at 4.08. When strong pedagogy was accompanied by a moderate gap, predicted readiness decreased to 3.78. The lowest estimate, 3.18, occurred when learners experienced only moderate pedagogical support together with a large discrepancy between teacher-reported and learner-experienced practices.

The pattern demonstrates that the quality and consistency of classroom enactment worked together. Strong pedagogical practices were most beneficial when learners clearly experienced the strategies that teachers intended to provide. Conversely, instructional practices lost part of their apparent advantage when the teacher and learner perspectives substantially diverged. This finding gives curriculum strengthening a practical meaning. Strengthening Science education did not depend solely on revising curricular content or increasing inquiry activities. It depended on making inquiry-oriented teaching sufficiently explicit, sustained, and learner-accessible.

Taken together, the findings showed that Senior High School Science pedagogy under the strengthened curriculum was moving toward stronger curriculum coherence and inquiry orientation, but important gaps remained. Teachers viewed their pedagogical adjustment more positively than learners did, particularly in adaptive scaffolding and inquiry facilitation. Learners demonstrated relatively strong participation and scientific explanation but remained less ready to formulate their own investigable questions and independently handle evidence. Most importantly, the Bayesian analysis showed that learner-experienced pedagogy positively predicted inquiry readiness, while increasing teacher-learner pedagogical discrepancy was associated with lower readiness. The results therefore point to a need for Science pedagogy that moves beyond the presence of inquiry activities toward consistent classroom enactment, stronger learner autonomy, and closer alignment between intended instruction and learners' actual learning experiences.

CONCLUSION

Reframing Senior High School Science pedagogy under the strengthened curriculum can support learner inquiry readiness when instructional practices are consistently experienced by learners and not merely intended by teachers. Curriculum coherence emerged as a relatively established practice, while adaptive scaffolding, inquiry facilitation, evidence handling, and learner-generated questioning remained areas requiring further attention. The observed gap between teacher-reported practices and learner classroom experiences suggests that successful curriculum strengthening depends on the quality and visibility of actual pedagogical enactment. Since stronger learner-experienced pedagogy was associated with higher inquiry readiness, Science teachers are encouraged to provide more sustained opportunities for learners to formulate investigable questions, analyze evidence independently, justify scientific claims, and participate in guided investigations that gradually increase learner autonomy. Schools may strengthen professional learning activities focused on inquiry facilitation, adaptive scaffolding, and evidence-centered assessment, while instructional monitoring should consider learner feedback alongside teacher self-reports to identify discrepancies in classroom implementation. Future curriculum support should therefore emphasize not only what Science teachers are expected to teach, but also how strengthened curriculum expectations are translated into consistent, inquiry-rich learning experiences.

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