ISSN: 3116-3475
International Journal
of Education, Research, and Innovation Perspectives
Volume 2 Issue 9 (September 2026)

Scientific Curiosity Building through Guided Inquiry in Secondary Science

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Date Submitted:
March 18, 2026

Date Accepted:
July 17, 2026

Date Published:
September 24, 2026

DOI:
10.5281/zenodo.22952150

ABSTRACT

This study examined how guided inquiry contributed to the development of scientific curiosity among Grade 9 learners in San Pablo, Isabela. Using a cross-sectional predictive survey design with a quantile-regression framework, the research involved 190 learners selected through proportionate stratified random sampling. Data were gathered using validated measures of guided inquiry experiences and scientific curiosity. Median, interquartile range, and median absolute deviation were used to describe the distributions of the variables, while quantile regression with 5,000 bootstrap resamples determined whether the predictive contribution of guided inquiry varied across levels of scientific curiosity. Results showed that learners experienced guided inquiry at a moderate level, while overall scientific curiosity was also moderate. Among the dimensions of curiosity, stretching and engagement in science practices were relatively stronger, whereas embracing uncertainty emerged as the weakest area. Guided inquiry significantly predicted scientific curiosity at the 25th, 50th, and 75th percentiles, with the strongest coefficient observed among learners in the lower curiosity group. The findings indicate that guided inquiry may be particularly beneficial for learners who demonstrate limited inclination to question, investigate, or persist in uncertain scientific situations. Strengthening guided questioning, evidence-based investigation, experimentation, and reflective explanation is therefore recommended, with differentiated teacher scaffolding based on learners' levels of scientific curiosity.

Keywords: *curiosity building, guided inquiry, inquiry-based learning, science education, scientific curiosity, secondary learners*

INTRODUCTION

Science learning becomes more meaningful when learners are not limited to receiving established explanations but are encouraged to ask why phenomena occur, examine possible answers, and pursue questions that emerge from observation. This disposition reflects scientific curiosity, which involves an interest in exploring scientific ideas and seeking explanations for unfamiliar events. Curiosity is particularly important during the secondary years because students are encountering concepts that increasingly require evidence, reasoning, and sustained investigation. Weible and Zimmerman (2016) identified science curiosity as an important aspect of science learning and emphasized that it can be developed across learning environments rather than treated simply as a fixed learner characteristic.

One instructional approach that can provide room for such curiosity is guided inquiry. In guided inquiry, learners participate in questioning, investigation, interpretation of evidence, and explanation while the teacher provides direction when needed. This balance allows students to exercise intellectual independence without leaving them to manage complex scientific tasks entirely on their own. Evidence from secondary learners showed that structured and guided inquiry contributed to the development of conceptual knowledge and inquiry abilities, suggesting that appropriate instructional guidance can support both understanding and participation in scientific investigation (Fang et al., 2016).

The value of inquiry also extends to how learners relate to science as a subject. When classroom activities invite students to investigate meaningful questions instead of merely following predetermined answers, science may become more personally engaging. Potvin et al. (2017) found that inquiry-based interventions produced a significant increase in secondary students' interest in science and technology. At the same time, greater learner independence does not automatically result in stronger learning. A systematic review by Dah et al. (2024) found positive outcomes of inquiry for conceptual understanding, motivation, scientific skills, and science literacy, but also pointed to the importance of teacher support, classroom management, and interaction during inquiry activities.

These findings place the Science teacher in a central position in cultivating curiosity. Inquiry requires more than providing experiments or asking students to discover answers. Teachers must shape questions, provide suitable scaffolds, encourage evidence-based reasoning, and create opportunities for learners to pursue ideas with genuine interest. A systematic review by Strat et al. (2024) likewise showed favorable outcomes of inquiry-based science education for scientific understanding, teaching competence, attitudes, and self-efficacy, while identifying continuing challenges in translating inquiry preparation into classroom practice. This makes it important to examine how guided inquiry is experienced and practiced within specific school settings.

Against this background, the study Scientific Curiosity Building through Guided Inquiry in Secondary Science sought to examine how guided inquiry relates to the development of scientific curiosity among secondary learners in San Pablo, Isabela. Rather than viewing curiosity merely as an individual tendency, the study considered how classroom opportunities for questioning, investigation, evidence gathering, and explanation may help strengthen learners' willingness to explore scientific ideas. Findings from the study may provide a clearer basis for designing Science instruction that maintains appropriate teacher guidance while giving learners meaningful opportunities to wonder, investigate, and make sense of scientific phenomena.

Literature Review

Scientific Curiosity in Secondary Science Learning

Scientific curiosity gives learners a reason to move beyond knowing facts toward questioning how and why scientific phenomena occur. During adolescence, this disposition may be strengthened or weakened by the kinds of experiences provided in the Science classroom. Lindholm (2018) argued that curiosity should remain a central feature of science education because questioning, uncertainty, and personal discovery are closely tied to the development of scientific thinking. Classroom practices, however, can restrict such tendencies when greater value is placed on compliance and completion than on intellectual exploration. Archer et al. (2017) observed that secondary Science classrooms may privilege routine performance and correct task completion in ways that limit learners' opportunities to express curiosity. Scientific curiosity, therefore, depends not only on learner disposition but also on whether classroom instruction gives students genuine space to wonder, question, and investigate.

Guided Inquiry as a Structure for Scientific Exploration

Guided inquiry provides a structured way for learners to participate in scientific investigation while receiving sufficient direction from the teacher. Rather than presenting knowledge as a finished body of information, it places students in situations where they examine questions, work with evidence, and develop explanations. Wen et al. (2020) found that a guided inquiry environment supported eighth-grade students with different levels of prior achievement in engaging with scientific investigation and contributed to gains in scientific literacy. Large-scale evidence also suggests that the level of teacher guidance matters. Aditomo and Klieme (2020) reported that inquiry was positively associated with learning outcomes when teacher guidance was present, whereas more independent forms of inquiry showed less favorable relationships with achievement. Guided inquiry therefore offers a useful balance between learner exploration and instructional structure.

Teacher Guidance and the Quality of Inquiry

The effectiveness of inquiry depends greatly on how teachers organize and support the learning process. Students may be given opportunities to conduct investigations, yet these activities can lose their educational value when questioning, evidence evaluation, and reflection are poorly guided. Kang (2022) found that instructional quality, particularly teacher-student relationships and classroom management, influenced the relationship between inquiry experiences and scientific literacy. This places the teacher in an active role as a facilitator who helps learners move from simple activity toward reasoned investigation. Such work is demanding because inquiry-based practical teaching involves challenges in lesson planning, classroom implementation, learner reflection, and assessment. Akuma and Callaghan (2019) consequently emphasized the importance of teachers' content knowledge, pedagogical competence, practical skills, and classroom management in conducting inquiry successfully.

Classroom Conditions for Building Scientific Curiosity

Curiosity is more likely to develop when students experience Science as something they can explore rather than simply memorize. This requires classroom activities that welcome questions, provide meaningful problems, permit investigation, and allow students to explain what they discover. Evidence from a public secondary school in the Philippines showed that Science teachers associated the development of scientific curiosity with active learning environments, responsive instruction, and pedagogical practices that encourage curiosity-driven inquiry (Nerio et al., 2025). These findings are especially relevant to the present study because they show that curiosity building is shaped by deliberate teaching practices rather than by student interest alone. Examining guided inquiry alongside scientific curiosity may therefore clarify which instructional experiences encourage secondary learners to become more willing to question, investigate, and seek scientific explanations.

METHODS

Research Design

The study employed a cross-sectional predictive survey design with a quantile-regression framework. This design was selected to determine how learners' exposure to guided inquiry was associated with scientific curiosity without restricting the analysis to an average relationship. Guided inquiry served as the explanatory variable, while scientific curiosity served as the outcome variable. Quantile regression allowed the relationship to be examined at different locations of the scientific-curiosity distribution, particularly among learners exhibiting lower, middle, and higher levels of curiosity. This approach provided a more differentiated account of the relationship than an analysis based solely on the conditional mean.

Research Locale

The study was conducted in the secondary education setting of San Pablo, Isabela. The municipality provided an appropriate setting because secondary learners received Science instruction through activities that included investigation, experimentation, questioning, evidence interpretation, and teacher-guided classroom inquiry. The locale also permitted the study to examine scientific curiosity within the actual instructional experiences of learners rather than through an artificial or laboratory-based setting.

Participants and Sampling Technique

The participants were 190 Grade 9 learners enrolled in public secondary education in San Pablo, Isabela. Grade 9 was selected because learners at this level engaged with science content requiring investigation, explanation, evidence use, and interpretation of scientific phenomena. Using Cochran's sample-size procedure with finite-population correction, a 95% confidence level, 5% margin of error, and .50 population proportion produced a required sample of 190 learners. Proportionate stratified random sampling was applied so that the number selected from each enrollment unit reflected its share of the population. Random numbers were then used to identify the individual participants. Only learners with parental consent and personal assent were included.

Research Instrument

Data were gathered using a two-part questionnaire measuring guided inquiry experiences and scientific curiosity. The first section contained nine items adapted from the Inquiry-Based Science Instruction Scale used by Areepattamannil et al. (2020). The items measured learners' involvement in scientific investigations, experimentation, interpretation of evidence, formulation of conclusions, explanation of ideas, and participation in scientific discussions. The original scale demonstrated satisfactory internal consistency across the national samples included in its validation.

Scientific curiosity was assessed using the 12-item Science Curiosity in Learning Environments Scale developed by Weible and Zimmerman (2016). The instrument measured three dimensions of scientific curiosity: stretching, embracing, and science practices. The scale was originally validated among 663 learners aged 8 to 18 through exploratory and confirmatory factor analyses and demonstrated strong psychometric properties. Published use of the measure reported an internal consistency coefficient of Cronbach's $\alpha = .91$.

Before the main administration, the combined questionnaire was reviewed by experts for content relevance, clarity, age appropriateness, and correspondence with the study variables. It was subsequently pilot-tested with 30 Grade 9 learners outside San Pablo, Isabela, who were excluded from the final sample. Cronbach's alpha was then computed separately for the guided inquiry and scientific curiosity scales and for the complete instrument. The resulting coefficients were used as the final evidence of internal consistency for the adapted questionnaire. Item wording and instructions were also reviewed following the pilot administration to ensure clarity and suitability for Grade 9 learners.

Data Gathering

Formal permission to conduct the study was secured from the appropriate education authorities before data collection. After approval, parental consent and learner assent forms were distributed to the selected participants. The questionnaire was administered during an agreed period that did not interfere with examinations or major instructional activities. Standardized instructions were given to ensure that all learners responded under comparable conditions. Participants completed the instrument individually, and completed questionnaires were checked for completeness before encoding. Responses were assigned numerical codes, and no learner names were entered into the analytical dataset.

Data Analysis

The data were first examined using the median, interquartile range, and median absolute deviation to describe the distribution of guided inquiry and scientific curiosity scores without relying solely on mean-based summaries. The principal inferential procedure was quantile regression, with scientific curiosity as the outcome and guided inquiry as the predictor. Models were estimated at the 25th percentile, 50th percentile, and 75th percentile of scientific curiosity. This procedure determined whether the contribution of guided inquiry differed among learners situated at lower, middle, and upper portions of the curiosity distribution. Statistical uncertainty was evaluated through 5,000 bootstrap resamples, with 95% confidence intervals reported for each quantile coefficient. Statistical significance was evaluated at $\alpha = .05$. This analytical strategy was selected because differences in curiosity building could be obscured when the relationship was represented by a single average regression coefficient.

Ethical Considerations

The study protected voluntary participation, informed parental consent, learner assent, confidentiality, and the right to discontinue participation without penalty. No personally identifying information was included in the dataset, responses were used solely for research purposes, and electronic records were stored in passwordprotected files accessible only to the researcher. Procedures involving minors were carried out with particular attention to privacy, minimal disruption, and freedom from academic consequences.

RESULTS AND DISCUSSION

Table 1. *Guided Inquiry Experiences of Grade 9 Learners*

Variable	Median	IQR	MAD	Interpretation
Guided inquiry	2.63	0.72	0.38	Moderate

Note. Guided inquiry was measured on a 4-point response scale. IQR = interquartile range; MAD = median absolute deviation.

Table 1 presents the learners' exposure to guided inquiry in science. The median of 2.63 indicated a moderate level of guided inquiry, while the IQR of 0.72 showed noticeable differences in how frequently learners experienced inquiry-oriented activities. The MAD of 0.38 further suggested that guided inquiry was not experienced with the same consistency across learners. The result indicates that investigation, experimentation, evidence interpretation, and conclusion building were present in science instruction, but these opportunities had not yet become a sustained feature of classroom learning. This finding points to an instructional concern because inquiry becomes more productive when sufficient teacher guidance is consistently provided. Lazonder and Harmsen (2016) found through a meta-analysis of 72 studies that guidance positively affected inquiry learning activities, performance success, and learning outcomes.

Table 2. *Scientific Curiosity of Grade 9 Learners*

Dimension	Median	IQR	MAD	Interpretation
Stretching	3.58	0.67	0.36	Moderately High
Embracing	2.94	0.91	0.52	Moderate
Science Practices	3.46	0.74	0.41	Moderately High
Overall Scientific Curiosity	3.39	0.72	0.40	Moderate

Note. Scientific curiosity was measured on a 5-point response scale.

Table 2 shows that overall scientific curiosity remained moderate, with a median of 3.39. Stretching obtained the highest median at 3.58, suggesting that learners generally showed willingness to seek information and learn about unfamiliar scientific ideas. Science practices also registered a moderately high median of 3.46, indicating interest in experimentation and active exploration. The weaker area was embracing, with a median of only 2.94 and the widest IQR of 0.91. Thus, although many learners were interested in discovering scientific information, they were less comfortable with uncertainty, unfamiliar situations, and problems without immediately apparent answers. This distinction is important because scientific curiosity includes stretching, embracing, and participation in science practices rather than information seeking alone. Research has likewise shown that individual differences in scientific curiosity are strongly connected with learners' tendency to seek new information and experiences (Williams et al., 2021).

Table 3. *Quantile Regression of Guided Inquiry on Scientific Curiosity*

Curiosity Quantile	B	Bootstrap SE	95% Bootstrap CI	p-value	Pseudo R^2
25th percentile	0.482	0.078	[0.329, 0.633]	< .001	0.196
50th percentile	0.351	0.064	[0.226, 0.478]	< .001	0.157
75th percentile	0.203	0.071	[0.064, 0.344]	.005	0.082

Note. N = 190. Estimates were based on 5,000 bootstrap resamples. Scientific curiosity was the outcome variable and guided inquiry was the predictor.

ISSN: 3116-3475
International Journal
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Table 3 presents the central finding of the study. Guided inquiry significantly and positively predicted scientific curiosity at all three points of the curiosity distribution. The strongest coefficient occurred at the 25th percentile, $B = 0.482$, $p < .001$, indicating that a one-unit increase in guided inquiry corresponded to a 0.482-unit increase in predicted scientific curiosity among learners situated in the lower portion of the curiosity distribution. The association remained significant at the median, $B = 0.351$, $p < .001$, and at the 75th percentile, $B = 0.203$, $p = .005$. The narrowing coefficients from the lower to the upper quantiles reveal an important instructional pattern. Guided inquiry was associated with curiosity across the learner distribution, but its strongest contribution appeared among students who initially showed weaker scientific curiosity.

This result suggests that guided inquiry may have particular value for learners who are less naturally inclined to question, explore, or remain engaged when scientific problems become uncertain. For these learners, teacher-supported investigations may provide the structure needed to transform passive participation into active questioning. Learners who already possessed stronger curiosity also benefited, although the smaller coefficient at the 75th percentile suggests less room for additional gains. Large-scale evidence similarly indicates that inquiry-based Science instruction is associated with important learner dispositions when investigation is accompanied by appropriate instructional support rather than left entirely unguided (Areepattamannil et al., 2020).

Taken together, the findings showed a clear instructional issue and an equally clear opportunity. Guided inquiry was only moderately experienced, and scientific curiosity was not uniformly strong, particularly in learners' willingness to embrace uncertainty. Yet guided inquiry significantly predicted curiosity throughout the distribution and showed its largest coefficient among learners with lower curiosity. Strengthening classroom opportunities for guided questioning, evidence gathering, experimentation, interpretation, and explanation may therefore be especially useful for students who are less inclined to explore scientific problems independently. The findings support a differentiated approach to curiosity building in which teacher guidance is intensified for learners who need greater structure while maintaining sufficient investigative freedom for those already demonstrating stronger scientific curiosity.

CONCLUSION

Guided inquiry was positively associated with the development of scientific curiosity among Grade 9 learners, with the strongest contribution observed among those who initially demonstrated lower levels of curiosity. Although learners showed a moderate level of guided inquiry exposure and overall scientific curiosity, their weaker tendency to embrace uncertainty indicated that many still needed structured opportunities to explore unfamiliar scientific problems with confidence. Based on these findings, Science teachers are encouraged to strengthen the regular use of guided questioning, evidence-based investigation, experimentation, and reflective explanation while providing closer scaffolding to learners who show limited curiosity and greater investigative independence to those who are already more engaged. Schools may also support teachers through focused professional development on guided inquiry design and classroom facilitation, while future studies may examine the effects of sustained guided inquiry interventions across different grade levels and Science disciplines.

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