

Knowledge, Attitude, And Motivation As Predictors Of Scientific Inquiry Skills Among Grade 7 Students In Surigao City

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Abstract

This study examined knowledge, attitude, and motivation as predictors of scientific inquiry skills among Grade 7 students in selected public and private secondary schools in Surigao City during Academic Year 2025-2026. Using a quantitative predictive-correlational design, data were gathered from 500 Grade 7 students and five science teachers through a researcher-developed 30-item science knowledge test, a teacher-rated scientific inquiry skills observation tool, the Scientific Attitude Scale, and the Science Motivation Questionnaire. Results showed that most students had good to excellent science knowledge, with 203 learners (40.60%) classified as good and 197 learners (39.40%) classified as excellent. Students also showed positive attitudes toward science ($M = 3.02$, $SD = 0.86$), positive motivation in science learning ($M = 3.08$, $SD = 0.80$), and demonstrated scientific inquiry skills ($M = 2.97$, $SD = 0.43$). Spearman's rho indicated a very high positive and significant relationship between knowledge and scientific inquiry skills ($\rho = 0.91$, $p < .001$), a negligible and non-significant relationship between attitude and inquiry skills ($\rho = 0.03$, $p = .514$), and a negligible but significant positive relationship between motivation and inquiry skills ($\rho = 0.19$, $p < .001$). Multiple regression analysis showed that knowledge, attitude, and motivation collectively explained 83% of the variance in scientific inquiry skills ($R = 0.91$, $R^2 = 0.83$), but knowledge was the only significant individual predictor ($\beta = 0.92$, $t = 48.68$, $p < .001$). The study proposes the Knowledge-Activated Inquiry (KAI) Model, which positions conceptual knowledge as the main activating condition for guided inquiry learning, with motivation and positive learning conditions serving as supportive factors. The findings suggest that strengthening students' scientific inquiry skills requires conceptually grounded, scaffolded, and evidence-based inquiry instruction.

Keywords: Scientific Inquiry Skills, Science Knowledge, Attitude Toward Science, Science Motivation, Knowledge-Activated Inquiry Model, Grade 7 Science

1. Introduction

Science education is central to the development of scientifically literate learners who can think critically, solve problems, and make evidence-based decisions. In contemporary classrooms, students are expected not only to remember scientific facts but also to apply concepts through observation, investigation, data interpretation, and explanation. Scientific inquiry therefore serves as both a process of learning science and an outcome of science education. It enables learners to ask questions, conduct investigations, examine evidence, and construct defensible

explanations of natural phenomena (National Academies of Sciences, Engineering, and Medicine [NASEM], 2018; Osborne, 2023).

Despite this curricular importance, developing inquiry skills remains difficult in many secondary science classrooms. Filipino learners, particularly those with lower proficiency in science, often experience difficulty applying concepts and engaging in higher-order scientific tasks (Bernardo et al., 2023). International and local research similarly indicates that inquiry-based learning can improve critical thinking and higher-order skills when it is deliberately scaffolded and connected to meaningful science tasks (Antonio & Prudente, 2024; Arifin et al., 2025). This evidence suggests that inquiry skills do not develop automatically through exposure to science content; they require structured learning conditions that help students connect concepts, procedures, and evidence.

Three learner-related factors are especially relevant to the development of inquiry skills: knowledge, attitude, and motivation. Science knowledge provides the conceptual foundation that enables students to observe phenomena meaningfully, select appropriate procedures, analyze information, and make evidence-based conclusions. Attitude toward science reflects students' interest, curiosity, and disposition toward scientific learning. Motivation sustains effort, persistence, and participation in inquiry-based activities. While these variables have been examined in science education research, fewer studies have investigated their combined predictive influence on the scientific inquiry skills of Grade 7 students in a localized Philippine setting.

Surigao City provides an appropriate context for this inquiry because its public and private secondary schools serve learners with varied institutional resources, classroom experiences, and science learning opportunities. Grade 7 is also a critical transition point because students begin to engage with more formal science concepts and laboratory-based tasks. Understanding which learner-related factor most strongly predicts inquiry performance may guide teachers and school leaders in designing targeted interventions that are evidence-based rather than assumption-driven.

The present study addressed this gap by examining knowledge, attitude, and motivation as predictors of scientific inquiry skills among Grade 7 students in Surigao City. The study generated empirical evidence for developing a Knowledge-Activated Inquiry (KAI) Model that can support science teachers in strengthening inquiry-based instruction through conceptual activation, guided investigation, and evidence-based reasoning.

Theoretical Framework

The study was anchored on three theoretical perspectives: the revised Bloom's Taxonomy, Bandura's Social Learning Theory, and Self-Determination Theory. The revised Bloom's Taxonomy frames knowledge as a cognitive structure that progresses from remembering and understanding to applying, analyzing, evaluating, and creating (Krathwohl, 2002). In this study, science knowledge was viewed as the cognitive basis for scientific inquiry because learners need conceptual understanding before they can interpret data, draw conclusions, and explain evidence.

Bandura's Social Learning Theory explains how learners' dispositions and behaviors are shaped through observation, modeling, and social interaction (Bandura, 1986). In the science classroom, attitude toward science may influence students' willingness to engage in tasks, participate in group investigations, and adopt scientific ways of thinking. Self-Determination Theory explains motivation through autonomy, competence, and relatedness (Ryan & Deci, 2000). Students who perceive themselves as competent and connected to meaningful learning tasks are more likely to persist in inquiry activities. Together, these perspectives frame scientific inquiry skills as an outcome of cognitive readiness, affective disposition, and motivational support.

Conceptual Framework

The conceptual framework assumed that knowledge, attitude, and motivation influence Grade 7 students' scientific inquiry skills. Scientific inquiry skills were operationalized through observing, measuring or using tools, collecting and recording data, analyzing and interpreting data, drawing conclusions, and using evidence to explain

scientific phenomena. Based on the empirical findings, the framework was refined into the Knowledge-Activated Inquiry (KAI) Model, which positions knowledge as the primary activating factor for inquiry performance, while motivation, attitude, teacher scaffolding, and supportive learning conditions sustain engagement in inquiry learning.

Figure 1
Knowledge-Activated Inquiry (KAI) Model for Developing Scientific Inquiry Skills

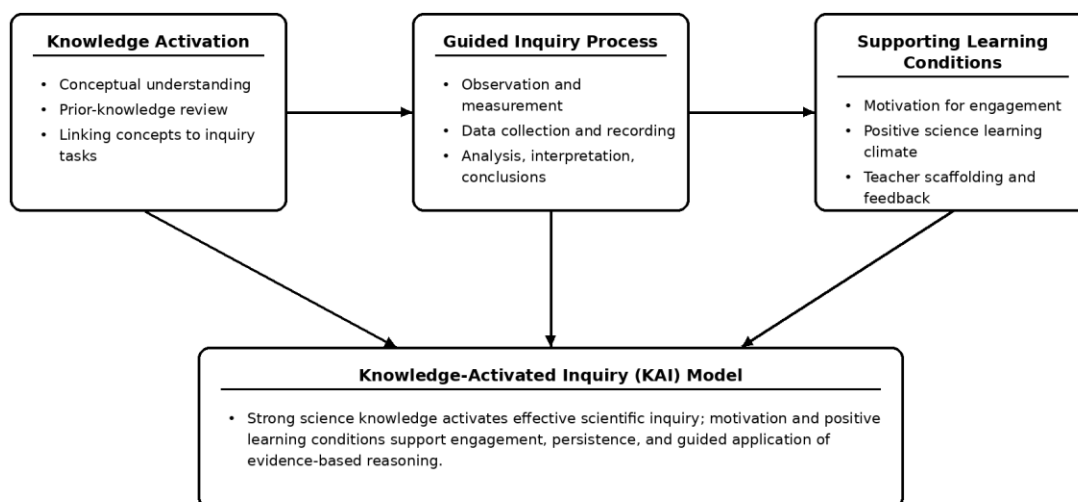


Figure note. The model positions science knowledge as the primary activating condition for scientific inquiry skills, while motivation, attitude, teacher scaffolding, and a supportive learning climate sustain engagement in guided inquiry learning.

Aim of the Study

This study aimed to determine the level of Grade 7 students' science learning in terms of knowledge, attitude, and motivation; examine the level of their scientific inquiry skills; determine the relationships between these variables; identify the extent to which knowledge, attitude, and motivation predict scientific inquiry skills; and propose an evidence-based instructional model to strengthen inquiry-based science learning.

Statement of the Problem

1. Determine the level of Grade 7 students' learning in science in terms of knowledge, attitude, and motivation.
2. Determine the level of Grade 7 students' scientific inquiry skills.
3. Test whether significant relationships exist between scientific inquiry skills and knowledge, attitude, and motivation.
4. Determine the extent to which knowledge, attitude, and motivation predict scientific inquiry skills.
5. Propose a teaching strategy or model to enhance the scientific inquiry skills of Grade 7 students based on the findings.

Hypotheses

H01: There is no significant relationship between Grade 7 students' knowledge, attitude, and motivation in science and their scientific inquiry skills.

H02: Knowledge, attitude, and motivation do not significantly predict or influence the scientific inquiry skills of Grade 7 students.

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2. Literature Review

Scientific inquiry is widely recognized as a core dimension of science learning because it develops students' ability to investigate phenomena, use evidence, and construct scientific explanations. Inquiry-based learning reflects constructivist assumptions that learners build understanding through active engagement, experience, and reflection (Ješková et al., 2022; Saputra et al., 2025). Empirical studies show that guided inquiry, laboratory activities, process-oriented inquiry, and active learning strategies improve science process skills, higher-order thinking, and scientific literacy (Antonio & Prudente, 2024; Farooq & Islam, 2023; Idul & Caro, 2022; Masunong & Cancio, 2025). These studies collectively indicate that inquiry skills require deliberate classroom opportunities for observation, measurement, data analysis, explanation, and communication.

Science knowledge functions as the cognitive infrastructure of inquiry. Students cannot analyze data, design explanations, or evaluate evidence without sufficient understanding of the concepts under investigation. Research on science learning consistently shows that conceptual knowledge supports reasoning, problem solving, and the application of scientific practices (Krajcik & Shin, 2023; NASEM, 2018; Supeno et al., 2022). Studies on inquiry-based laboratory work also show that conceptual understanding and scientific skills can develop together when instruction links content knowledge with authentic investigation (Valls-Bautista et al., 2021; Suwono et al., 2023). This supports the assumption that knowledge is not merely an input to inquiry; it is a condition that allows inquiry processes to become meaningful.

Attitude toward science contributes to students' learning experiences by shaping interest, curiosity, and perceived value of the subject. Positive attitudes can encourage learners to participate in science activities, collaborate with peers, and view science as relevant to real-life problems (Kumar & Acharya, 2025; Tytler & Ferguson, 2023). However, the relationship between attitude and performance is not always direct. Some studies report that inquiry-based instruction improves science process skills more strongly than attitudes (Aktamiş et al., 2016; Şimşek & Kabapınar, 2010). This suggests that positive disposition may support engagement but may not be sufficient to produce inquiry competence without structured practice and conceptual knowledge.

Motivation is also relevant to inquiry learning because it influences persistence, effort, and willingness to engage with difficult tasks. Motivation in science may be intrinsic, such as curiosity and enjoyment, or extrinsic, such as grades and career aspirations (Mubeen & Reid, 2014; Ryan & Deci, 2000). Recent studies show that collaborative learning, inquiry-based instruction, formative assessment, gamification, and technology-supported environments can strengthen science motivation and engagement (Bawaneh & Alnamshan, 2023; Ismail et al., 2022; Loes, 2022; Membiela et al., 2023). Yet motivation may influence inquiry indirectly by increasing participation rather than by independently producing skill mastery.

The reviewed literature suggests that scientific inquiry skills are shaped by the interaction of cognitive and affective-motivational factors. Knowledge provides the conceptual base, attitude shapes willingness to engage, and motivation sustains effort during inquiry tasks. However, prior studies often examine these variables separately or focus mainly on instructional strategies. The present study contributes by testing their combined predictive influence on Grade 7 students' scientific inquiry skills in Surigao City and by translating the findings into a context-responsive instructional model.



3. Methodology

Research Design

The study employed a quantitative predictive-correlational research design. This design was appropriate because the study sought to describe students' levels of knowledge, attitude, motivation, and scientific inquiry skills and determine the extent to which the independent variables predicted the dependent variable. The design allowed the researcher to analyze naturally occurring relationships among variables without manipulation.

Participants and Locale

The participants were 500 Grade 7 students from selected public and private secondary schools in Surigao City during Academic Year 2025-2026. The schools were Caraga Regional Science High School, Surigao del Norte National High School, Surigao City National High School, Taft National High School, and St. Paul University Surigao. Equal allocation was used, with 100 Grade 7 students from each school. Five science teachers also participated by rating students' scientific inquiry skills using the observation tool. The student sample allowed representation across participating school contexts while maintaining feasibility under school-based data collection protocols.

Research Instruments

Four instruments were used. First, a researcher-developed 30-item summative assessment measured Grade 7 students' science knowledge based on identified third-quarter competencies. The tool underwent expert validation by four validators from public and private institutions. Second, students' attitudes toward science were measured using a modified Scientific Attitude Scale based on Akkuş (2020). Third, students' motivation in learning science was measured using the Science Motivation Questionnaire of Mubeen and Reid (2014). Fourth, scientific inquiry skills were assessed through a teacher-rated observation tool covering observing, measuring or using tools, collecting and recording data, analyzing and interpreting data, drawing conclusions, and using evidence to explain. The observation tool used a four-point scale ranging from Not Demonstrated to Highly Demonstrated.

Table 1. Learning Gap Analysis Used in Developing the Knowledge Assessment

Learning competency	Correct responses	Mastery level
Identify that forces act between objects and can be measured.	86.75%	Closely Approaching Mastery
Identify and describe balanced and unbalanced forces in everyday situations.	49.80%	Average Mastery
Draw a free-body diagram showing relative magnitude and direction of forces.	77.91%	Moving Towards Mastery
Identify that unbalanced forces can change speed or direction.	79.12%	Moving Towards Mastery
Explain the difference between distance and displacement in everyday situations.	36.95%	Average Mastery
Distinguish between speed and velocity using vectors.	55.22%	Average Mastery
Describe uniform velocity and represent it using distance-time graphs.	53.82%	Average Mastery

Explain the difference between heat and temperature.	73.49%	Moving Towards Mastery
Identify examples of conduction, convection, and radiation.	66.47%	Moving Towards Mastery
Explain convection and conduction using the particle model.	83.53%	Moving Towards Mastery
Identify innovative devices that transform heat energy into electrical energy.	34.94%	Low Mastery

Data Gathering Procedure

Permission was secured from the school principals of the participating schools. The research purpose, target participants, instruments, and schedule were coordinated with Grade 7 science coordinators and class advisers. Data collection was conducted during an approved schedule to avoid disruption of regular instruction. Students who were present, available, and willing to participate answered the instruments under supervised conditions. While students completed the questionnaires and knowledge assessment, the participating science teachers accomplished the inquiry skills observation tool based on students' actual science classroom performance.

Ethical Considerations

The study observed ethical standards for educational research involving minors. Student assent was obtained using clear and age-appropriate language. Participation was voluntary, and students were informed of their right to decline or withdraw without penalty. Confidentiality and anonymity were maintained through coding procedures. Data were used only for academic research purposes and were handled in accordance with the Philippine Data Privacy Act of 2012.

Data Analysis

Frequency counts and percentage distributions were used to describe students' knowledge levels. Means and standard deviations were used to interpret attitudes, motivation, and scientific inquiry skills. Spearman's rho was used to examine the relationships between scientific inquiry skills and the independent variables because it is suitable for ordinal data and does not require normality. Multiple linear regression was used to determine the extent to which knowledge, attitude, and motivation predicted scientific inquiry skills. All inferential analyses were interpreted at the 0.05 level of significance.

4. Results / Findings

Level of Knowledge, Attitude, Motivation, and Scientific Inquiry Skills

Table 2. Grade 7 Students' Level of Science Knowledge

Knowledge level	f (n = 500)	%
Poor (0-20%)	24	4.80
Fair (21-40%)	76	15.20
Good (41-60%)	203	40.60
Excellent (61-100%)	197	39.40

Table 2 shows that most respondents had good to excellent science knowledge. Specifically, 203 students (40.60%) were classified as good, while 197 students (39.40%) were classified as excellent. Together, these categories represented 80.00% of the sample. Only 76 students (15.20%) were classified as fair and 24 students (4.80%) as

poor. The pattern indicates that most Grade 7 students had sufficient conceptual foundations for science learning, although a smaller group still required remediation and differentiated support.

Table 3. Summary of Attitude, Motivation, and Scientific Inquiry Skills

Variable / indicator	Mean	SD	Interpretation
Attitude toward science - overall	3.02	0.86	Positive Attitude
Highest attitude indicator: People should understand scientific facts since it affects life	3.34	0.73	Strong Positive Attitude
Motivation in science - overall	3.08	0.80	Positive Motivation
Highest motivation indicator: Confidence in performing well in science examinations	3.51	0.50	Strong Positive Motivation
Scientific inquiry skills - overall	2.97	0.43	Demonstrated
Highest inquiry skill: Observing	3.30	0.75	Highly Demonstrated
Lowest inquiry skill: Analyzing/interpreting data	2.61	0.49	Demonstrated
Lower inquiry skill: Measuring/using tools	2.63	0.82	Demonstrated

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The students generally showed positive attitudes toward science and positive motivation in science learning. The highest attitude indicator showed that students recognized the value of scientific facts in everyday life. Motivation was also evident in students' confidence and persistence. For scientific inquiry skills, the overall mean of 2.97 indicated that inquiry skills were demonstrated. Observing was the strongest skill, while analyzing and interpreting data and measuring or using tools were the weakest areas. These lower areas indicate that students may need more frequent exposure to laboratory tasks, graph interpretation, measurement activities, and evidence-based explanation exercises.

Relationships Between Predictors and Scientific Inquiry Skills

Table 4. Significant Relationships Between Scientific Inquiry Skills and Knowledge, Attitude, and Motivation

Variable correlated with scientific inquiry skills	Spearman rho	p-value	Decision	Interpretation
Knowledge	0.91	< .001	Reject H01	Very high positive significant relationship
Attitude	0.03	.514	Accept H01	Negligible non-significant relationship
Motivation	0.19	< .001	Reject H01	Negligible positive significant relationship

Table 4 indicates that knowledge had a very high positive and significant relationship with scientific inquiry skills. Students with stronger science knowledge were more likely to demonstrate inquiry skills effectively. Motivation

also had a statistically significant relationship with inquiry skills, but the strength of association was negligible. Attitude showed a negligible and non-significant relationship. These results suggest that affective and motivational conditions may support classroom participation, but conceptual knowledge is the factor most directly connected to inquiry performance.

Predictive Influence of Knowledge, Attitude, and Motivation

Table 5. Multiple Regression Analysis Predicting Scientific Inquiry Skills

Predictor	R	R ²	Adjusted R ²	B	SE	Beta	t	p-value	Decision
Constant	0.91	0.83	0.83	1.74	0.07		25.27	< .001	
Knowledge	0.91	0.83	0.83	0.07	0.00	0.92	48.68	< .001	Significant
Attitude	0.91	0.83	0.83	-0.04	0.02	-0.03	-1.72	.086	Not significant
Motivation	0.91	0.83	0.83	-0.02	0.02	-0.02	-0.94	.348	Not significant

The regression model was statistically meaningful, with knowledge, attitude, and motivation explaining 83% of the variance in students' scientific inquiry skills. However, only knowledge emerged as a significant individual predictor. The standardized beta value for knowledge (beta = 0.92) shows that it dominated the model. Attitude and motivation did not significantly predict inquiry skills after knowledge was entered into the model. This finding indicates that students' ability to conduct inquiry depends primarily on whether they have sufficient science concepts to activate during observation, measurement, data interpretation, and evidence-based explanation.

Proposed Knowledge-Activated Inquiry (KAI) Model

Table 6. Basis for the Proposed KAI Model and Intervention Program

Problem area	Empirical finding	Intervention direction	Expected outcome
Application of scientific knowledge in inquiry	Knowledge had a very high relationship with inquiry skills and was the only significant predictor.	Activate prior knowledge, build conceptual understanding, and connect concepts to inquiry tasks.	Stronger application of science knowledge during investigations.
Inquiry-based learning experiences	Measuring and analyzing/interpreting data had the lowest means.	Provide hands-on investigations, measurement activities, data interpretation tasks, and evidence-based reasoning.	Improved competence in practical and analytical inquiry processes.
Student engagement	Motivation had a significant but weak relationship with inquiry skills.	Use meaningful tasks, collaborative activities, formative feedback, and supportive classroom practices.	Greater participation, persistence, and engagement during inquiry.
Higher-order scientific reasoning	Analyzing/interpreting data was the lowest inquiry skill.	Use graph interpretation, questioning strategies, data analysis worksheets, and evidence-based discussions.	Improved reasoning and interpretation of scientific information.

The proposed KAI Model translates the results into a classroom-oriented instructional framework. Its central principle is that knowledge activation must precede inquiry performance. Students should first recall, clarify, and

organize relevant scientific concepts before engaging in observation, measurement, data gathering, interpretation, and explanation. Motivation and positive attitudes are retained as supportive learning conditions because they sustain participation and persistence, but the model gives instructional priority to conceptual activation and guided inquiry practice.

5. Discussion

The findings confirm that scientific inquiry skills are primarily knowledge-dependent. Although students generally demonstrated positive attitudes and motivation, these factors did not independently predict inquiry performance when knowledge was considered. This suggests that students may enjoy science or feel motivated to participate, but such dispositions do not automatically produce competence in interpreting data, drawing conclusions, or using evidence. Inquiry skills require cognitive tools: students must understand scientific concepts before they can use those concepts to investigate phenomena.

The strong role of knowledge is consistent with studies emphasizing that inquiry-based learning requires conceptual grounding and scaffolded practice (NASEM, 2018; Supeno et al., 2022; Valls-Bautista et al., 2021). Students who possess stronger knowledge can more effectively identify relevant details, connect observations with scientific principles, interpret data, and justify explanations. This explains why knowledge accounted for much of the variance in inquiry skills in the present study.

The weak or non-significant predictive roles of attitude and motivation should not be interpreted as educationally irrelevant. Rather, the findings clarify their role. Attitude and motivation may facilitate participation, enjoyment, confidence, and persistence, but they need to be paired with explicit instruction, conceptual scaffolding, and repeated inquiry practice. This distinction is important for science teachers because improving engagement alone may not be sufficient. Instruction must connect engagement to content mastery and systematic inquiry processes.

The weakest inquiry areas, particularly analyzing/interpreting data and measuring/using tools, point to the need for more structured laboratory and data-based learning experiences. These skills require practice with instruments, tables, graphs, patterns, evidence, and reasoning. Accordingly, the proposed KAI Model recommends the use of diagnostic questioning, concept organizers, guided investigation worksheets, graph interpretation activities, and evidence-based discussion as regular parts of Grade 7 science instruction.

6. Conclusion and Recommendations

Conclusion

The study concludes that Grade 7 students' scientific inquiry skills are strongly and significantly shaped by their level of science knowledge. While students generally demonstrated positive attitudes and motivation toward science, these variables did not independently predict inquiry skills after knowledge was considered. The findings indicate that inquiry competence depends primarily on students' conceptual readiness to observe, measure, collect and interpret data, draw conclusions, and use evidence to explain scientific phenomena. Therefore, science instruction should prioritize knowledge activation and scaffolded inquiry practice rather than relying only on motivation-building or attitude-enhancing activities. The proposed Knowledge-Activated Inquiry (KAI) Model provides a practical framework for connecting conceptual understanding with guided scientific investigation.

Recommendations

Students should strengthen their conceptual knowledge in science by reviewing lessons through concept maps, explanation exercises, real-life examples, and inquiry questions that require evidence-based answers. They should also participate actively in hands-on investigations, measurement tasks, graph interpretation, and group inquiry activities to improve weaker skills such as analyzing data and using tools.

Science teachers should adopt a scaffolded inquiry-based approach that begins with concept activation before students perform investigations. Teachers may use diagnostic questions, guided inquiry worksheets, concept organizers, data tables, graphing tasks, and evidence-based reflection prompts. Lessons should move from concrete experiences to conceptual explanation and then to inquiry application.

School administrators should support inquiry-based science learning by providing basic laboratory materials, measuring tools, science kits, printed and digital learning resources, and professional development activities. Learning Action Cell sessions may focus on designing guided inquiry tasks, contextualizing experiments, and assessing scientific inquiry skills using observable performance indicators.

Future researchers may test the Knowledge-Activated Inquiry (KAI) Model through classroom intervention studies using pretest-posttest, quasi-experimental, or mixed-methods designs. Further studies may also examine other predictors of inquiry skills, such as teacher competence, classroom environment, laboratory access, reading comprehension, socio-economic background, and prior academic achievement.

Declarations

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CRedit Authorship Contribution Statement

Jade Stephanie B. Cerezo: Conceptualization, Methodology, Investigation, Data Collection, Formal Analysis, Writing - Original Draft, and Project Administration. Florabel P. Mutia: Supervision, Validation, Methodological Guidance, Writing - Review and Editing, and Academic Advising.

Ethical Statement

The study observed ethical standards for educational research involving student participants. Administrative permission was secured from the participating schools. Student assent was obtained before data collection. Participation was voluntary, and confidentiality, anonymity, and data privacy were maintained throughout the study.

Declaration of Competing Interest

The authors declare no competing financial, institutional, personal, or professional interests that may have influenced the conduct, interpretation, or reporting of this study.

Data Availability Statement

The data supporting the findings of this study are available from the authors upon reasonable request, subject to applicable privacy and school-based data protection requirements.

AI Usage Disclosure

AI-assisted tools were used only for language refinement, organization, formatting support, and manuscript preparation assistance. The authors reviewed, verified, and approved the final content of the manuscript.

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