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Inquiry-Based Instruction and Students' Conceptual Mastery in Junior High School Mathematics: Basis for a Contextualized Instructional Enhancement Program in Eastern Tabuk District III, Kalinga

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Abstract
This study examined inquiry-based instruction and students' conceptual mastery in junior high school mathematics in Eastern Tabuk District III, Tabuk City, Kalinga, during School Year 2025-2026. It determined students' perceptions of inquiry-based instruction in terms of student engagement, critical thinking and problem-solving, collaboration and communication, use of real-world applications, and teacher facilitation and support. It also assessed students' conceptual mastery and analyzed the relationship between the two variables. The study used a descriptive-correlational design with 200 junior high school students from Grades 7 to 10 selected through stratified random sampling. Data were gathered through a structured questionnaire and treated using weighted mean and Pearson correlation. Results showed that students agreed that inquiry-based learning was evident in engagement, critical thinking, collaboration, and real-world applications, while teacher facilitation and support was rated strongly agreed. Students also demonstrated a high level of conceptual understanding. All inquiry-based learning domains were positively and significantly related to conceptual understanding, with real-world applications having the strongest relationship. The study concludes that inquiry-based instruction strengthens meaningful mathematical learning when supported by guided facilitation, collaborative tasks, and authentic problem situations. A contextualized instructional enhancement program is proposed to improve students' conceptual mastery in mathematics.

Keywords: Conceptual Mastery, Inquiry-based Instruction, Instructional Enhancement, Junior High School Mathematics, Real-world Applications

1. Introduction
Mathematics education has moved beyond teaching learners to memorize procedures and arrive at quick answers. Current reforms in mathematics place stronger value on reasoning, interpretation, representation, and the ability to use mathematics in familiar and unfamiliar situations. The PISA 2022 framework describes mathematical literacy as the capacity to reason mathematically and formulate, employ, and interpret mathematics across varied life situations (OECD, 2023). In the Philippine basic education system, this direction is consistent with curriculum efforts that value problem solving, communication, and meaningful application rather than mechanical practice alone (Department of Education, 2023).

Inquiry-based instruction responds to this need because it places learners in an active role. Instead of receiving every procedure from the teacher, students investigate problems, ask questions, test ideas, compare solution paths, and explain their thinking. Studies on inquiry-oriented mathematics instruction report that guided inquiry can increase engagement, strengthen reasoning, and help learners build connections between procedures and concepts (Riegle-Crumb et al., 2019; Lethulur et al., 2022; Lumabit and Sagge Jr., 2023). Such work is important in junior high school, where students are expected to move from concrete numerical work toward algebraic, geometric, and statistical reasoning. Recent classroom studies also connect inquiry-based learning with stronger interest, achievement, and conceptual understanding in mathematics (Ijeh, 2020; Nurlaili et al., 2023; Afore: Jurnal Pendidikan Matematika, 2025).

However, inquiry-based learning is not simply a matter of letting students discover ideas without structure. Recent reviews warn that inquiry works best when learners receive purposeful scaffolding, timely questioning, and clear feedback from teachers (Evans and Dietrich, 2022; Ton and Van Merriënboer, 2023). Guided inquiry asks teachers to create a learning path where students have room to think, but they are not left unsupported. This balance is especially important in mathematics classrooms where misconceptions can easily persist when students are not guided to compare, justify, and refine their solutions.

Conceptual mastery is also receiving renewed attention because students may compute correctly without understanding why a method works. Jones et al. (2024) explain that assessing mathematical understanding requires attention to reasoning, connections, and representations, not only final answers. In the same way, inquiry tasks that use real-life problems can help students see the usefulness of mathematics and apply concepts with greater confidence (Ocampo et al., 2023; Yu et al., 2024). When students discuss ideas with classmates, explain their methods, and relate mathematics to everyday experiences, they become more likely to treat mathematics as a tool for thinking rather than a set of isolated rules.

Despite these gains, gaps remain in local classroom practice. Many studies on inquiry-based mathematics focus on senior high school, higher education, or non-Philippine classrooms. Less attention has been given to junior high school students' perceptions of inquiry-based instruction in districts such as Eastern Tabuk District III. There is also a need to connect these perceptions with students' conceptual mastery so that instructional programs can be designed from actual learner experiences and classroom data.

This study therefore examined inquiry-based instruction and students' conceptual mastery in junior high school mathematics in Eastern Tabuk District III, Tabuk City, Kalinga. It focused on student engagement, critical thinking and problem-solving, collaboration and communication, real-world applications, and teacher facilitation and support. It also determined the level of students' conceptual understanding and tested the relationship between inquiry-based learning and conceptual mastery. The findings served as the basis for a contextualized instructional enhancement program for mathematics.

2. Material and methods

2.1 Research Design

The study employed the descriptive-correlational research design. The descriptive component was used to determine the extent of inquiry-based instruction as perceived by the students and their level of conceptual understanding in mathematics. The correlational component was used to determine the relationship between inquiry-based instruction and students' conceptual mastery. This design was appropriate because the study sought to describe existing classroom experiences and examine whether students who perceived stronger inquiry-based instruction also reported higher conceptual understanding.

2.2 Locale of the Study

The study was conducted in Eastern Tabuk District III, Tabuk City, Kalinga, specifically among junior high school students from Grades 7 to 10 during School Year 2025-2026. The locale was selected because the study focused on students who experienced mathematics learning activities where inquiry-based instruction was applied.

2.3 Respondents of the Study

The participants were 200 junior high school students from Grades 7 to 10 in Eastern Tabuk District III, Tabuk City, Kalinga, during School Year 2025-2026.

2.4 Sample and Sampling Procedure

Stratified random sampling was used to ensure balanced representation across grade levels, with 50 students selected from each grade level. The participants were chosen because they were directly involved in mathematics learning activities where inquiry-based instruction was applied.

2.5 Research Instrument

A structured questionnaire was used as the main research instrument. The first part measured the extent of inquiry-based instruction in terms of student engagement, critical thinking and problem-solving, collaboration and communication, use of real-world applications, and teacher facilitation and support. The second part measured students' conceptual understanding in mathematics, including their ability to explain solution steps, understand reasoning behind formulas, connect topics, apply concepts to real-life situations, and represent mathematical ideas in different forms. The instrument used a five-point Likert scale. For inquiry-based instruction, the responses ranged from Strongly Disagree to Strongly Agree. For conceptual understanding, the responses ranged from Very Low to Very High.

2.6 Data Gathering Procedure

Permission was secured from the concerned school authorities before data collection. The researcher personally administered the questionnaire to the selected students, explained the purpose of the study, and gave them sufficient time to answer. The completed questionnaires were collected and checked for completeness.

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2.7 Data Analysis Techniques

Weighted mean was used to determine the extent of inquiry-based instruction and the level of conceptual understanding. Pearson correlation was used to determine the relationship between inquiry-based instruction and students' conceptual mastery. Statistical results were interpreted using the decision rules appropriate to the rating scale and level of significance.

2.8 Ethical Considerations

The study observed ethical procedures in the collection and treatment of data. The participants were informed about the purpose of the study, and their participation was treated as voluntary. No names or identifying details were included in the manuscript. Responses were kept confidential and used only for research purposes. The study also observed respect for learners' privacy and complied with school protocols on data gathering.

3. Results and Discussion

3.1 Extent of Inquiry-Based Learning as Perceived by the Students

Table 1. *Extent of inquiry-based learning as perceived by the students in terms of student engagement*

Student Engagement	Mean	Qualitative Description
I actively participate in mathematics activities.	4.12	Agree
I am motivated to explore math topics on my own.	3.85	Agree
Inquiry-based activities make math lessons more interesting.	4.26	Strongly Agree
I enjoy discovering solutions during math class.	3.97	Agree
I feel responsible for my own learning in math.	4.08	Agree
Grand Mean	4.06	Agree

The category mean for student engagement was 4.06, interpreted as Agree. The highest indicator was that inquiry-based activities make mathematics lessons more interesting (M = 4.26, Strongly Agree), followed by active participation in mathematics activities (M = 4.12), feeling responsible for one's own learning (M = 4.08), enjoyment in discovering solutions (M = 3.97), and motivation to explore mathematics topics independently (M = 3.85). This pattern means that inquiry-based instruction helped students become more involved in lessons, although independent exploration still needed further support. This finding agrees with research showing that inquiry tasks can improve participation when learners are given meaningful questions, classroom interaction, and teacher guidance (Riegle-Crumb et al., 2019; Lumabit and Sagge Jr., 2023).

Table 2. *Extent of inquiry-based learning as perceived by the students in terms of critical thinking and problem-solving*

Critical Thinking and Problem-Solving	Mean	Qualitative Description
I analyze math problems deeply before solving them.	4.18	Agree
I use different strategies to solve math problems.	4.05	Agree
I can justify my answers with logical reasoning.	3.92	Agree
I reflect on the methods I use to solve math problems.	3.76	Agree
Inquiry-based learning helps me develop critical thinking skills.	4.28	Strongly Agree
Grand Mean	4.04	Agree

The category mean for critical thinking and problem-solving was 4.04, interpreted as Agree. The highest indicator was that inquiry-based learning helps students develop critical thinking skills (M = 4.28, Strongly Agree), followed by analyzing mathematics problems deeply (M = 4.18), using different solution strategies (M = 4.05), justifying answers with logical reasoning (M = 3.92), and reflecting on the methods used to solve problems (M = 3.76). The results indicate that students were able to think through problems, but reflection on solution methods required more deliberate classroom practice. Recent studies on inquiry-based learning similarly note that questioning, justification, and reflective problem solving help students strengthen higher-order thinking (Karakas and Sarikaya, 2025; Yu et al., 2024).

Table 3. *Extent of inquiry-based learning as perceived by the students in terms of collaboration and communication*

Collaboration and Communication	Mean	Qualitative Description
I regularly work with classmates to solve math problems.	4.12	Agree
I share my ideas clearly during group activities.	4.07	Agree
I learn new strategies from classmates during inquiry activities.	4.15	Agree
Group work helps me understand math concepts better.	4.22	Agree
I listen and respond respectfully to my classmates' ideas.	4.35	Strongly Agree

Collaboration and Communication	Mean	Qualitative Description
Grand Mean	4.18	Agree

The category mean for collaboration and communication was 4.18, interpreted as Agree. The highest indicator was listening and responding respectfully to classmates' ideas (M = 4.35, Strongly Agree), followed by group work helping students understand mathematics concepts better (M = 4.22), learning new strategies from classmates (M = 4.15), regularly working with classmates to solve problems (M = 4.12), and sharing ideas clearly during group activities (M = 4.07). These results show that peer discussion was a strong part of inquiry-based learning, but students could still improve in expressing their own mathematical reasoning. Collaborative inquiry has been found to support analytical thinking because learners test ideas, negotiate meanings, and compare strategies with peers (Yu et al., 2024; Ako Aotearoa, 2023).

Table 4. *Extent of inquiry-based learning as perceived by the students in terms of use of real-world applications*

Use of Real-World Applications	Mean	Qualitative Description
Math problems relate to real-life situations.	4.20	Agree
I understand how math is used in everyday life.	4.18	Agree
Real-world problems help me understand math concepts.	4.25	Strongly Agree
I solve problems related to actual events or situations.	4.10	Agree
Inquiry-based tasks help me apply math in real-life situations.	4.28	Strongly Agree
Grand Mean	4.20	Agree

The category mean for use of real-world applications was 4.20, interpreted as Agree. The highest indicator was that inquiry-based tasks help students apply mathematics in real-life situations (M = 4.28, Strongly Agree), followed by real-world problems helping them understand concepts (M = 4.25, Strongly Agree), mathematics problems relating to real-life situations (M = 4.20), understanding how mathematics is used in everyday life (M = 4.18), and solving problems related to actual events or situations (M = 4.10). The findings indicate that students valued mathematics more when lessons were connected to lived experiences. This aligns with OECD (2023), which frames mathematical literacy around using mathematics to interpret and act on real-life situations, and with local findings that students' mathematics performance benefits when instruction is connected to learners' experiences (Ocampo et al., 2023).

Table 5. *Extent of inquiry-based learning as perceived by the students in terms of teacher facilitation and support*

Teacher Facilitation and Support	Mean	Qualitative Description
My teacher encourages me to ask questions.	4.30	Strongly Agree
My teacher guides me in exploring math concepts.	4.15	Agree
My teacher provides helpful feedback during inquiry activities.	4.22	Agree
My teacher creates a supportive learning environment.	4.35	Strongly Agree
My teacher encourages collaboration and discussion.	4.18	Agree
Grand Mean	4.24	Strongly Agree

The category mean for teacher facilitation and support was 4.24, interpreted as Strongly Agree. The highest indicator was that the teacher creates a supportive learning environment (M = 4.35, Strongly Agree), followed by encouraging students to ask questions (M = 4.30, Strongly Agree), providing helpful feedback during inquiry activities (M = 4.22), encouraging collaboration and discussion (M = 4.18), and guiding students in exploring mathematics concepts (M = 4.15). These results show that teacher support was central to the success of inquiry-based mathematics instruction. Recent work on inquiry-based tasks emphasizes that students learn more deeply when teachers provide scaffolding, feedback, and purposeful questions rather than leaving learners to discover ideas without guidance (Evans and Dietrich, 2022; Ton and Van Merriënboer, 2023).

3.2 Level of Students' Conceptual Understanding in Mathematics

Table 6. *Level of students' conceptual understanding in mathematics*

Statement Indicators	Mean	Qualitative Description
I can explain the steps I use to solve math problems.	4.12	High
I understand the reasoning behind mathematical formulas.	4.05	High
I can connect different math topics to solve complex problems.	3.95	High
I can apply math concepts in real-life situations.	4.20	High
I can represent math ideas in various ways (e.g., graphs, equations, diagrams).	4.08	High
I can identify and correct my own math errors.	4.18	High

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Statement Indicators	Mean	Qualitative Description
I can solve unfamiliar problems using known strategies.	4.10	High
I understand not just how but why a math procedure works.	4.22	High
I can compare and contrast different math methods.	3.98	High
I can transfer my learning in math to new and different problems.	4.15	High
Grand Mean	4.10	High

The category mean for students' conceptual understanding was 4.10, interpreted as High. The highest indicator was understanding not only how but why a mathematics procedure works (M = 4.22), followed by applying concepts in real-life situations (M = 4.20), identifying and correcting one's own errors (M = 4.18), transferring learning to new and different problems (M = 4.15), explaining solution steps (M = 4.12), solving unfamiliar problems using known strategies (M = 4.10), representing ideas in different forms (M = 4.08), understanding the reasoning behind formulas (M = 4.05), comparing and contrasting different methods (M = 3.98), and connecting different mathematics topics to solve complex problems (M = 3.95). The ratings show that learners had a solid grasp of concepts, but making connections across topics remained the area that needed the most reinforcement. Jones et al. (2024) stress that conceptual understanding must be assessed through reasoning, connections, and representations; therefore, students need tasks that ask them to explain, compare, and apply ideas beyond routine exercises.

3.3 Relationship Between Inquiry-Based Learning and Students' Conceptual Understanding

Table 7. *Relationship between inquiry-based learning and students' conceptual understanding in mathematics*

Inquiry-Based Learning	Correlation Coefficient (r)	p-value	Interpretation
Student Engagement	.42*	.010	Significant relationship
Critical Thinking and Problem-Solving	.55**	< .001	Highly significant relationship
Collaboration and Communication	.48**	< .001	Highly significant relationship
Use of Real-World Applications	.60**	< .001	Highly significant relationship
Teacher Facilitation and Support	.52**	< .001	Highly significant relationship

The relationship results show that all inquiry-based learning domains were significantly related to students' conceptual understanding. The strongest relationship was observed in use of real-world applications ($r = .60$, $p < .001$), followed by critical thinking and problem-solving ($r = .55$, $p < .001$), teacher facilitation and support ($r = .52$, $p < .001$), collaboration and communication ($r = .48$, $p < .001$), and student engagement ($r = .42$, $p = .010$). These findings indicate that students tended to report higher conceptual understanding when they experienced mathematics lessons that were connected to real-life situations, required reasoning, involved guided facilitation, and allowed peer interaction. This supports recent studies showing that inquiry-based mathematics learning becomes more powerful when it combines authentic tasks, collaborative reasoning, and structured teacher support (Lethulur et al., 2022; Lumabit and Sagge Jr., 2023; Yu et al., 2024).

3.4 Proposed Instructional Enhancement Program

Table 8. *Enhancing conceptual understanding in mathematics through inquiry-based learning (IBL-Math Program)*

Program Component	Objectives	Activities/Strategies	Persons Involved	Time Frame	Expected Outcomes
Student Engagement Workshops	Increase active participation and motivation in mathematics lessons.	Gamified inquiry tasks; math exploration days; reflective learning journals.	Mathematics teachers; students	Quarterly	Higher participation and stronger self-directed learning.
Critical Thinking and Problem-Solving Clinics	Develop higher-order thinking and reflective problem-solving skills.	Problem-based sessions; strategy-sharing workshops; error-analysis activities.	Mathematics teachers; peer tutors; students	Monthly	Improved reasoning and flexible problem-solving.
Collaborative Learning Circles	Strengthen teamwork and communication in mathematics.	Peer teaching; group investigations; math roundtable discussions.	Students; facilitating teachers	Bi-monthly	Stronger collaboration and exchange of solution strategies.
Real-World Application Projects	Connect mathematics concepts to authentic	Community-based math projects; real-life problem sets; cross-disciplinary tasks with Science/Technology.	Teachers; students; community partners	Per quarter	Greater appreciation of mathematics and

Program Component	Objectives	Activities/Strategies	Persons Involved	Time Frame	Expected Outcomes
	and practical situations.				better application of concepts.
Teacher Facilitation and Support Training	Enhance teachers' facilitation skills in guided inquiry.	Professional development; peer coaching; lesson study; training on scaffolding, questioning, and feedback.	School heads; mathematics teachers; experts	Semi-annual	Teachers become more skilled in inquiry-based facilitation.
Conceptual Understanding Assessment System	Monitor students' conceptual understanding and provide timely feedback.	Performance-based assessments; rubric-based evaluation; student self-assessment tools.	Teachers; students	Continuous	Clear evidence of growth in conceptual understanding.
Program Monitoring and Evaluation	Assess program effectiveness and adjust strategies when needed.	Student and teacher feedback; classroom observations; pre- and post-assessment comparison.	Program committee; teachers; school heads	End of each semester	Program results reviewed and continuously improved.

The proposed IBL-Math Program was drawn from the results of the study. Since real-world applications had the strongest relationship with conceptual understanding, the program gives a major place to community-based mathematics tasks and authentic problem sets. It also includes activities for student engagement, critical thinking, collaboration, teacher facilitation, assessment, and monitoring. The program responds to the need for guided inquiry rather than unguided discovery, as research shows that students benefit most when inquiry tasks are supported by clear scaffolds, feedback, and opportunities to communicate mathematical reasoning (Evans and Dietrich, 2022; Jones et al., 2024; Ton and Van Merriënboer, 2023).

4. Conclusion & Recommendations

Based on the findings, junior high school students in Eastern Tabuk District III perceived inquiry-based instruction positively across all measured domains. Student engagement, critical thinking and problem-solving, collaboration and communication, and real-world applications were rated Agree, while teacher facilitation and support was rated Strongly Agree. These results show that students experienced mathematics lessons as more active, participatory, and guided when inquiry-based strategies were used. The students also demonstrated a high level of conceptual understanding in mathematics. They reported being able to explain procedures, apply concepts to real-life situations, identify errors, solve unfamiliar problems, and transfer learning to new tasks. However, connecting different mathematics topics to solve complex problems received the lowest mean, indicating the need for more integrative activities that link concepts across lessons and grade levels. All domains of inquiry-based learning were positively and significantly related to students' conceptual understanding. Real-world applications had the strongest relationship, followed by critical thinking and problem-solving, teacher facilitation and support, collaboration and communication, and student engagement. These results indicate that inquiry-based instruction can strengthen conceptual mastery when students are guided to reason, collaborate, and apply mathematics to meaningful problems. The proposed IBL-Math Program may therefore be used as a practical guide for improving mathematics instruction in the district.

Based on the findings, mathematics teachers may implement the proposed IBL-Math Program by giving more real-world application projects, critical-thinking clinics, collaborative learning circles, and guided inquiry tasks. School heads may support teachers through lesson study, peer coaching, training on scaffolding and feedback, and regular monitoring of students' conceptual understanding so that mathematics instruction becomes more connected, reflective, and meaningful for learners.

The study was limited to 200 junior high school students from Grades 7 to 10 in Eastern Tabuk District III, Tabuk City, Kalinga, during School Year 2025-2026. Since data were gathered through questionnaire responses and analyzed using weighted mean and Pearson correlation, the findings may not fully capture classroom observations, teacher perspectives, or long-term changes in mathematics achievement. Results should therefore be interpreted within the specific locale, respondents, and instruments used in the study.

Compliance with ethical standards

The study adhered to institutional ethical standards in the conduct of educational research. Participation was voluntary, the purpose of the study was explained to the student-participants, and informed consent and school protocols were observed before data collection. No names or identifying details were included in the manuscript, and responses were treated with confidentiality and used only for research purposes. The authors take responsibility for the integrity of the work, acknowledge the contributions and sources used in the study, retain copyright responsibility for the manuscript, and declare that no conflict of interest was involved in its preparation.

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