

Original Article

Mathematics Achievement of Grade 9 Students During the Implementation of Structured Problem-Solving Instruction

Marcel-Ono A. Palad 

Author Information:

Osmeña Colleges Graduate School, Masbate, Philippines

Dimasalang National High School
Dimasalang, Masbate, Philippines

Corresponding Author:

paladmarcelono@gmail.com

Article History:

Date received: April 7, 2026

Date revised: May 4, 2026

Date accepted: May 15, 2026

Recommended citation:

Palad, M.-O. (2026). Mathematics achievement of Grade 9 students during the implementation of structured problem-solving instruction. *Journal of Interdisciplinary Perspectives*, 4(6), 278-292.
<https://doi.org/10.69569/jip.2026.017>

Abstract. This study examined changes in Grade 9 students' mathematics achievement during the implementation of structured problem-solving instruction (SPSI) in a public secondary school in Masbate, Philippines. Specifically, it aimed to describe students' mathematics performance, determine whether significant differences existed between pretest and posttest scores on the Rapid Mathematics Assessment (RMA) and Albay Numeracy Assessment Tool (ALNAT), and describe students' perceptions of the instructional approach. Using a quantitative one-group pretest-posttest design, the study involved 90 Grade 9 students for the pretest-posttest analyses, while 49 students with complete matched data were included in the perception, correlation, and regression analyses. Data were analyzed using descriptive statistics, paired-samples t-tests, Pearson correlation, and multiple regression. Results showed that RMA scores increased from pretest ($M = 20.56$, $SD = 11.38$) to posttest ($M = 25.36$, $SD = 16.59$), $t(89) = -3.39$, $p = .001$. ALNAT scores also increased from pretest ($M = 27.73$, $SD = 7.36$) to posttest ($M = 38.42$, $SD = 13.37$), $t(89) = -7.02$, $p < .001$. Students generally reported positive perceptions of SPSI, particularly regarding classroom support and step-by-step problem-solving. However, perception variables were not significantly correlated with RMA or ALNAT gains, and the regression model did not significantly predict RMA improvement, $F(4, 44) = 1.20$, $p = .326$, adjusted $R^2 = .016$. The findings indicate that students' mathematics achievement increased during the year in which SPSI was implemented, but the design does not permit strong causal claims. The results suggest that SPSI may be a promising classroom approach, while further studies using comparison groups are needed to isolate its effect.

Keywords: *Achievement gains; Mathematics achievement; Perception survey; Pretest-posttest design; Structured problem-solving instruction.*

Mathematics education in the Philippines, whether in rural or urban settings, continues to face persistent challenges. Students often balance schoolwork with external difficulties, and these challenges may be intensified by the country's geographic and environmental conditions. Public secondary schools, especially those in rural and coastal areas, commonly experience limited resources, varied learner readiness, and interruptions in instructional time (Aquino et al., 2025). Reports on climate-related class suspensions further suggest that environmental disruptions can affect continuity of learning and make conventional instruction more difficult to sustain (Tuazon, 2024). These conditions highlight the need for instructional approaches that are

practical, structured, and responsive to local classroom realities.

Concerns about students' mathematics performance also remain evident at the national level. International assessment results from PISA 2022 indicate that Filipino students continue to struggle with mathematics, particularly in applying mathematical concepts to real-world situations (OECD, 2023). National assessment discussions likewise indicate persistent performance concerns, especially in tasks requiring reasoning and problem solving (Santos et al., 2025). Although curriculum reforms in the K-12 Mathematics Curriculum emphasize reasoning, application, and problem solving, gaps in numeracy and mathematical comprehension remain, particularly among learners in under-resourced and geographically marginalized contexts.

To address these concerns, mathematics education increasingly emphasizes structured approaches to problem solving. Problem solving has long been treated as central to mathematics learning, with Polya's work emphasizing systematic stages of understanding, planning, solving, and checking. Cognitive perspectives also stress the importance of reasoning and conceptual understanding in the secondary years (Manouchehri & Sriraman, 2020). In addition, metacognitive perspectives highlight the role of monitoring, strategy selection, and reflection in mathematical problem solving (Güner & Erbay, 2021). Cognitive load theory further suggests that instruction should be designed to help learners manage the mental demands of complex tasks (Sentz et al., 2019).

Recent research also supports the relevance of structured instructional models in mathematics classrooms. Structured problem-solving instruction may include guided practice, modeling, stepwise solution processes, and opportunities for reflection, all of which can support students' mathematical reasoning and performance (Kadir, 2023). Problem-solving tasks that involve real-life applications, collaborative activities, and guided explanations may also promote student engagement and conceptual understanding (Roorda et al., 2024). Repeated exposure to structured mathematical tasks may help students interpret, analyze, and apply mathematical concepts more effectively (Agbata et al., 2024). Collaborative problem-solving approaches have also been associated with active participation and critical thinking development (Xu et al., 2023).

Formative assessment is likewise relevant to structured mathematics instruction. Timely and actionable feedback can help teachers monitor learning, identify gaps, and adjust instruction during problem-solving activities (Nhan, 2024). When assessment is aligned with instruction, students may receive clearer guidance on both procedural accuracy and reasoning processes. In structured problem-solving settings, formative assessment can therefore support the development of mathematical confidence, skill, and understanding.

Local and regional studies also support problem-centered and contextualized approaches to mathematics instruction. Research on mathematics interventions in Philippine or comparable classroom contexts suggests that structured and contextualized strategies may support reasoning, engagement, and performance (Rojo et al., 2024). Studies involving Grade 9 students and approaches such as Realistic Mathematics Education have also reported improvement in problem-solving skills (Caraan et al., 2022). Diagnostic tools such as the Rapid Mathematics Assessment (RMA) and the Albay Numeracy Assessment Tool (ALNAT) are useful in identifying learning gaps and monitoring student progress across mathematics competencies.

Despite these positive indications, implementation remains complex, particularly in rural and coastal schools. In Masbate Province, mathematics instruction may be affected by weather disturbances, limited resources, varied learner readiness, and interruptions in classroom learning. These conditions require instructional strategies that can be implemented even when learning time and resources are constrained. They also underscore the need to examine students' achievement patterns in authentic classroom settings rather than only in controlled intervention contexts.

Several gaps remain in the existing literature. First, many studies on structured problem-solving instruction are conducted in more controlled, urban, or better-resourced settings, while fewer studies examine disruption-prone rural or coastal contexts. Second, limited classroom-based evidence uses both the RMA and ALNAT to monitor changes in mathematics performance. Third, there is a need to distinguish between observed achievement gains and causal claims about instructional effectiveness. This distinction is important because a one-group pretest-posttest design can show change over time. However, it cannot fully rule out alternative explanations, such as exposure to the regular curriculum, maturation, teacher familiarity, repeated testing, or broader school factors.

To address these gaps, this study examined changes in Grade 9 students' mathematics achievement over one academic year during which structured problem-solving instruction was implemented. Using pretest and posttest data from the RMA and ALNAT, together with a student perception survey, the study aimed to: (1) describe students' mathematics performance; (2) determine whether significant differences existed between pretest and posttest scores; and (3) describe students' perceptions of structured problem-solving instruction in terms of interest and participation, problem-solving difficulties, perceived effects of the teaching approach, and classroom support. The study also examined whether perception variables were significantly associated with achievement gains.

The findings of this study are expected to contribute to both practice and research. For educators, the study may offer practical insights into implementing structured problem-solving routines in a rural public secondary school. For school leaders and curriculum planners, the findings may inform discussions on numeracy support, scaffolded instruction, and context-responsive mathematics teaching. For future researchers, the study highlights both the usefulness and the limitations of classroom-based pretest–posttest evidence. It supports the need for future studies with comparison groups or stronger quasi-experimental designs.

Methodology

Research Design

This study used a quantitative one-group pretest–posttest design to examine changes in Grade 9 students' mathematics achievement during one academic year in which structured problem-solving instruction was implemented. This design was appropriate for documenting whether students' RMA and ALNAT scores changed from the beginning to the end of the instructional period. However, because the study did not include a comparison or control group, the design does not establish that structured problem-solving instruction alone caused the observed changes. Other factors, such as regular curriculum exposure, student maturation, repeated testing, teacher familiarity, and broader school conditions, may also have contributed to score changes.

The instructional period covered an estimated 197 hours of mathematics classes, with each session lasting approximately 60 minutes. This estimate excluded time lost due to local class suspensions, weather disturbances, and typhoons. Throughout the academic year, instruction emphasized structured problem-solving strategies, including teacher-led and student-led think-aloud activities, guided practice, real-world word problems, collaborative board work, and reflective solution discussions. The instructional cycle included problem comprehension, strategy formulation, execution of solution steps, and solution verification. The approach was implemented across quarters, with emphasis adjusted according to topic complexity and students' learning needs.

Although semi-structured interview guides were initially prepared to gather information on students' experiences, engagement, challenges, and perceptions, the interview data were not formally coded or thematically analyzed. Therefore, the present manuscript does not report a qualitative strand and is presented as a quantitative classroom-based pretest–posttest study with a perception survey.

Participants and Sampling Technique

The participants were 90 Grade 9 students enrolled in a public junior high school in one municipality of Masbate Province, Philippines, during School Year 2025–2026. The study used total population sampling for the pretest–posttest analysis because all students in the researcher's Grade 9 mathematics classes who met the inclusion criteria were included. The inclusion criteria were enrollment in Grade 9 during the school year and availability of complete pretest and posttest scores for the RMA and ALNAT. Students who transferred, were absent during either test administration, or had incomplete assessment data were excluded from the relevant analysis.

The full sample of $N = 90$ was used for the RMA and ALNAT pretest–posttest analyses. However, only $n = 49$ students were included in the perception, correlation, and regression analyses because they had complete matched data for the perception survey, RMA scores, and ALNAT scores. Missing data occurred because some students were absent during survey administration, and others submitted incomplete or invalid responses. No statistical comparison was conducted between students with complete perception data and those excluded from the perception-related analyses. Therefore, possible missing-data bias cannot be ruled out and is acknowledged as a limitation of the study.

Frequency Tables

Table 1. *Gender of Participant*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	28	31.1	31.1	31.1
	Female	62	68.9	68.9	100.0
	Total	90	100.0	100.0	

Table 2. *Age of Participant*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	14	4	4.4	4.4	4.4
	15	68	75.6	75.6	80.0
	16	14	15.6	15.6	95.6
	17	2	2.2	2.2	97.8
	18	1	1.1	1.1	98.9
	19	1	1.1	1.1	100.0
	Total	90	100.0	100.0	

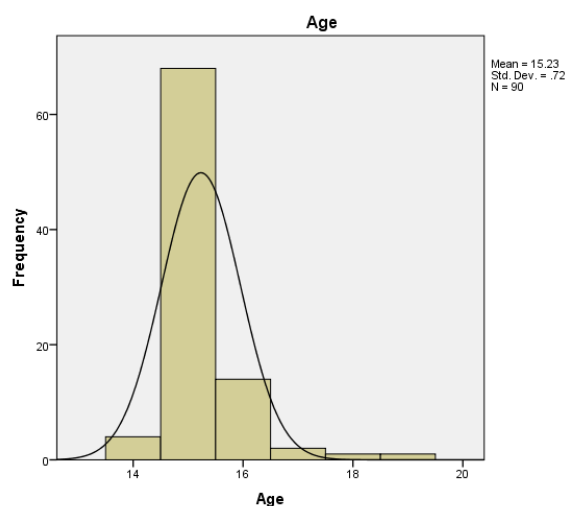


Figure 1. *Frequency Distribution by Age*

Research Instruments

This study employed a combination of standardized mathematics assessments and a researcher-developed perception survey to comprehensively examine students' numeracy performance and learning experiences.

Standardized Mathematics Assessments

Students' mathematics achievement was measured using two validated assessments: the Rapid Mathematics Assessment (RMA) and the Albay Numeracy Assessment Tool (ALNAT). The RMA is a national diagnostic assessment developed by the Department of Education (DepEd) under the National Learning Recovery Program, while ALNAT is a regional assessment implemented by DepEd Region V and supported by Regional Memorandum No. 113, s. 2022 and No. 00402, s. 2025. Both instruments align with the K-12 Mathematics Curriculum and assess numeracy domains, including number operations, algebra, geometry, and data interpretation (DepEd-Central Office, 2023; SDO-Albay, 2022).

Conceptual and Theoretical Basis

The construction of RMA and ALNAT is grounded in the K to 12 Mathematics Framework, which incorporates constructivist principles, a progression-based view of numeracy development, and the hierarchy of cognitive processes outlined in Bloom's taxonomy. Item development follows DepEd's competency-based assessment design, ensuring alignment with the Most Essential Learning Competencies (MELCs) and grade-level curriculum standards.

Development and Validation Processes

Although specific psychometric indices (e.g., Cronbach's alpha) were not publicly accessible, both instruments followed DepEd's institutional assessment development cycle. This includes blueprinting using a Table of Specifications (TOS), expert review, content validation, pilot testing, and item analysis. The RMA was developed in collaboration with expert institutions such as UP NISMED to ensure psychometric soundness and consistency with national mathematics assessment standards (Padayon UP, 2023; UP NISMED, 2023; Dulay, 2025). Given their standardized nature and validated use in national and regional learning assessments, the RMA and ALNAT were used in their original forms. Recalculation of reliability was not conducted because reliability is a property of the test itself, established during large-scale validation, and should not be recomputed using small classroom samples.

Description of Standardized Instruments

The RMA consists of 47 items covering number expressions, variables, equations, geometry, graphs, and related competencies. The ALNAT comprises 50 items in multiple-choice and contextualized formats aligned with MELCs for Grades 1–10. Its development included collaboration with UP NISMED, Bicol University College of Education (BUCE), division content specialists, and IT experts. Pilot testing was conducted via online and paper-and-pencil administration, followed by item analysis to establish validity and reliability. Implementation adheres to DepEd Orders No. 8, s. 2015; No. 55, s. 2016; and No. 31, s. 2020 (Luces, 2022). Both assessments were constructed using a Table of Specifications to ensure alignment with the curriculum's content standards, performance expectations, and cognitive demand levels.

Researcher-Developed Perception Survey Questionnaire

To complement the standardized assessments and capture students' learning experiences in Structured Problem-Solving Instruction (SPSI), a researcher-developed Perception Survey Questionnaire was constructed. The survey's design was informed by theoretical frameworks including George Pólya's problem-solving model, Jean Piaget's constructivist theory, Lev Vygotsky's social constructivism, and Albert Bandura's social learning theory. These frameworks guided the operational definitions of the constructs measured.

Survey Structure

The instrument consists of four subscales measured using a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree):

Interest and Participation in Mathematics (IPM; 8 items)
Difficulties in Solving Mathematics Problems (DSMP; 7 items)
Effects of the Teaching Approach (ETA; 8 items)
Classroom Support (CS; 5 items)

Content Validity

Content validity was established through evaluation by three mathematics educators with doctoral qualifications and 20–26 years of professional experience. They assessed item clarity, relevance, and alignment with intended constructs. Their feedback guided revisions to improve clarity and representativeness.

Pilot Testing and Reliability Analysis

Pilot testing was conducted with 49 Grade 9 students from the same school, but not part of the main sample. The pilot test assessed item clarity, instructions, response patterns, administration time, and the instrument's initial psychometric properties. Feedback led to refinements in item wording and sequencing.

Internal consistency reliability was evaluated using Cronbach's alpha in IBM SPSS Statistics. The reliability coefficients reported in Table 3 were based on the pilot-test administration and were used to assess the survey's internal consistency before final data collection. Coefficients for the four subscales were as follows: IPM ($\alpha = .801$), DSMP ($\alpha = .815$), ETA ($\alpha = .825$), and CS ($\alpha = .765$). All values exceeded the recommended threshold of 0.70, indicating acceptable to good reliability, see Table 3.

Table 3. *Reliability Coefficients for Each Subscale*

Subscale	No. of items	Cronbach's Alpha (α)	Interpretation
Interest and Participation in Mathematics (IPM)	8	.801	Good Reliability
Difficulties in Solving Mathematics Problems (DSMP)	7	.815	Good Reliability
Effects of the Teaching Approach (ETA)	8	.825	Good Reliability
Classroom Support (CS)	5	.765	Acceptable Reliability

Construct and Criterion Validity

Construct validity was inferred from alignment with the theoretical models underlying the survey and from the consistent correlations among subscales, which provided evidence of convergent validity. Criterion-related validity was assessed through Pearson correlations between perception scores and students' achievement gains in RMA and ALNAT. Results showed weak, non-significant correlations, indicating that perceptions of instruction were not directly associated with short-term test score gains—an expected outcome in instructional research. Nonetheless, strong intercorrelations among the subscales supported the survey's internal coherence.

Definition of Instruments and Instructional Approach

The study used the following definitions for clarity:

Rapid Mathematics Assessment (RMA): A diagnostic tool administered at the start and end of the school year to identify learners' numeracy strengths and weaknesses.

Albay Numeracy Assessment Tool (ALNAT): A regional diagnostic assessment developed under DepEd Region V – SDO Albay Project Numerals to measure foundational mathematics skills aligned with K-12 competencies.

Perception Survey Questionnaire: A researcher-developed instrument measuring interest and participation, problem-solving difficulties, effects of the teaching approach, and classroom support.

Structured Problem-Solving Instruction (SPSI): A teacher-led instructional approach emphasizing repeated problem solving, guided modeling, think-aloud strategies, collaborative board work, scaffolded practice in Filipino and Minasbate, real-world tasks, and time-pressured problem-solving activities.

Data Gathering Procedure

Data collection was conducted over one school year and followed four phases:

1. **Pretesting Phase** – RMA and ALNAT pretests were administered under standardized, face-to-face settings starting in the first week of the school year. The total time allocated for both assessments was 90 minutes. No review of the exact test items was allowed to prevent score inflation.
2. **Intervention Phase** – Students received structured problem-solving instruction embedded into regular math lessons. SPSI included explicit strategy modeling, guided practice with the ICT integration using online digital learning tools, student and teacher think-aloud demonstrations, monitored problem-solving on boards and seatwork, and scaffolded group tasks.
3. **Post-testing Phase** – The same RMA and ALNAT instruments were administered at the end of the instructional period under identical testing conditions and following the same assessment schedule used in the pretest phase.
4. **Perception Survey on SPSI** – Students completed the Likert-scale questionnaire to evaluate their experiences during SPSI.

The researcher administered all procedures in a face-to-face classroom environment.

Data Analysis Procedure

Quantitative data were analyzed using descriptive and inferential statistics. Means and standard deviations were computed to describe students' RMA and ALNAT pretest and posttest scores, as well as their responses to the perception survey. Paired-samples t-tests were used to determine whether significant differences existed between pretest and posttest scores on the RMA and ALNAT.

Cohen's d was computed to estimate the magnitude of pretest–posttest change. Effect sizes were calculated for the full pretest–posttest sample and for the subsample with complete matched perception and achievement data.

These effect sizes were interpreted as indicators of the magnitude of observed change over time, not as proof that SPSI alone caused the change.

Pearson correlation was used to examine whether perception variables were significantly associated with RMA and ALNAT gain scores. Multiple regression was used to examine whether the perception variables predicted RMA gain. Gain scores were used because the study aimed to examine the relationship between students' perceived classroom experiences and the amount of observed pretest–posttest change. However, gain-score analysis has limitations, especially with a modest subsample and without statistical control for baseline performance. Therefore, the results of correlation and regression analyses were interpreted cautiously. A stronger future analysis may examine posttest performance while controlling for pretest scores using ANCOVA-type procedures or repeated-measures models.

Normality was assessed using the Shapiro–Wilk test, together with visual inspection of histograms and normal Q–Q plots. Some variables showed deviations from normality, but visual inspection suggested that these deviations were not severe. Given the sample size and the robustness of parametric procedures to moderate deviations from normality, paired-samples *t*-tests, Pearson correlation, and multiple regression analyses were retained.

All statistical analyses were conducted using IBM SPSS Statistics version 20, with supplementary data organization in Microsoft Excel.

Ethical Considerations

The study followed standard ethical protocols for educational research. Permission was obtained from the Schools Division Office of Masbate and the school administration. Students and parents were informed of the study's purpose, procedures, and voluntary nature. Assent forms were collected from students, and parents or legal guardians signed consent forms. Confidentiality was ensured by anonymizing data and securing all digital and printed records. No identifiable personal information was disclosed, and participation had no bearing on academic grades.

The researcher did not intentionally reproduce, post, or publicly share any items from the *RMA* (47 items) and the *ALNAT* (50 items). This was done to fully comply with copyright, test security, and ethical standards regarding standardized assessments in the Department of Education. Both assessments are protected instruments administered annually by DepEd public schools. Releasing test items would compromise their validity for future diagnostic cycles. Schools and divisions in Region V recently issued strict guidance against online circulation of standardized test items. This study follows those directives. It reports only aggregated scores and statistical results, without reproducing or describing any specific test questions, to maintain security standards and the integrity of the instruments for future use.

Results and Discussion

This study examined Grade 9 students' mathematics achievement during one academic year in which structured problem-solving instruction was implemented in a rural public secondary school. The results are presented according to the study objectives: pretest–posttest changes in RMA and ALNAT scores, students' perceptions of structured problem-solving instruction, and the association between perception variables and achievement gains. Because the study used a one-group pretest–posttest design without a comparison group, the results are interpreted as observed changes over time rather than as conclusive evidence that structured problem-solving instruction alone caused the changes.

SPSI and Improvements in Procedural and Foundational Skills

Table 4 presents descriptive statistics for RMA and ALNAT pretest and posttest scores.

Table 4. <i>Descriptive Statistics for RMA and ALNAT Pretest and Posttest Scores (N = 90)</i>					
Test	<i>M</i>	<i>SD</i>	<i>N</i>	<i>t</i>	<i>P</i>
RMA Pretest	20.56	11.38	90	–3.393	.001
RMA Posttest	25.36	16.59	90		
ALNAT Pretest	27.73	7.36	90	–7.017	< .001
ALNAT Posttest	38.42	13.37	90		

The RMA results showed a statistically significant increase from pretest ($M = 20.56$, $SD = 11.38$) to posttest ($M = 25.36$, $SD = 16.59$), $t(89) = -3.39$, $p = .001$. This indicates that students' RMA scores increased during the academic year in which structured problem-solving instruction was implemented. Because the RMA included items requiring interpretation, reasoning, and application, the observed gain suggests some improvement in students' higher-order mathematical performance. However, the magnitude of change was smaller than the gain observed in ALNAT scores.

The ALNAT results also showed a statistically significant increase from pretest ($M = 27.73$, $SD = 7.36$) to posttest ($M = 38.42$, $SD = 13.37$), $t(89) = -7.02$, $p < .001$. This result indicates a stronger observed gain in students' foundational numeracy and procedural performance. Since ALNAT is aligned with foundational mathematics competencies, the result suggests that students showed greater improvement in procedural and numeracy-related skills than in broader reasoning-oriented performance.

These findings are consistent with research suggesting that structured and scaffolded instruction may support mathematics learning by making solution processes explicit and reducing unnecessary cognitive demands during problem solving. Guided examples, repeated practice, think-aloud demonstrations, and structured feedback may help learners focus on essential procedures and solution steps (Sentz et al., 2019; Ngu & Phan, 2024). The stronger ALNAT gain is also consistent with the idea that procedural fluency may respond more readily to repeated practice and step-by-step instruction than higher-order reasoning, which often develops more gradually through sustained engagement with complex tasks. **Figure 1** illustrates the difference in gains between ALNAT and RMA.

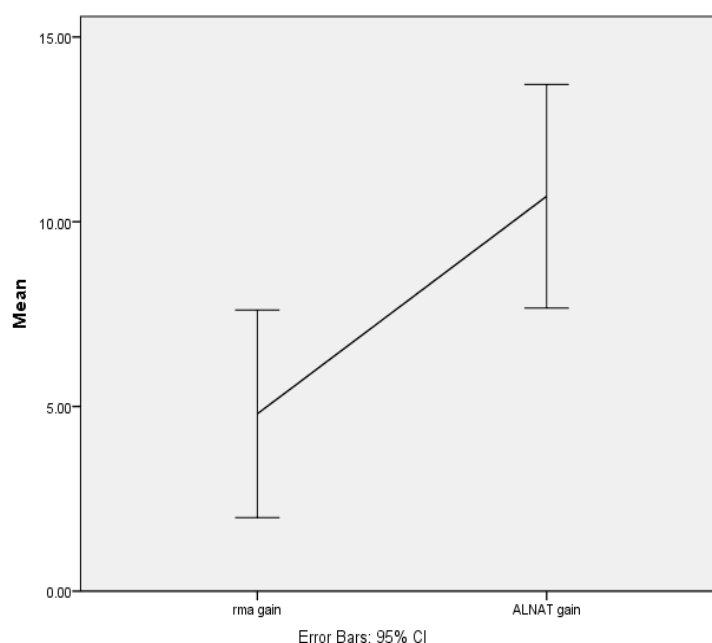


Figure 1. Pretest–Posttest Gains in RMA vs ALNAT

The figure highlights that although both assessments showed increased scores, the sharper gain in the ALNAT suggests stronger observed improvement in foundational and procedural skills than in reasoning-oriented performance during the implementation period. This pattern is plausible in contexts where students may benefit from explicit demonstrations, guided steps, and scaffolded routines—elements that directly support the acquisition of basic operations and algorithmic procedures. The rural learning environment further magnifies the significance of these gains. Limited internet connectivity, intermittent power supply, and frequent weather disruptions constrain opportunities for sustained, resource-rich learning. Under such conditions, structured, low-complexity instructional routines become especially powerful because they remain effective even when technological and environmental supports are scarce. At the same time, existing research cautions that contextual factors can modulate outcomes in ways that do not always privilege procedural fluency. Some interventions draw on domain-general cognitive improvements—such as working memory and executive function—that influence both fluency and reasoning, while others yield stronger gains in reasoning when instruction foregrounds

mathematical language, vocabulary development, and discourse-rich problem-solving (Koponen et al., 2019; Yang et al., 2022). Thus, the differential improvement observed in this study reflects not only the nature of the intervention but also the constraints and affordances of a rural educational setting.

Magnitude of Observed Achievement Changes

To clarify the practical magnitude of the pretest–posttest changes, paired-samples effect sizes were computed. Table 7 presents the effect sizes for the pretest–posttest changes in RMA and ALNAT scores.

Table 5. Paired-Samples *t*-Test for RMA Pretest and Posttest Scores (*N* = 90)

Variable	Mean	SD	<i>t</i> -value	<i>df</i>	<i>p</i> -value	Decision
RMA Pretest	20.56	11.38				
RMA Posttest	25.36	16.59	-3.393	89	.001	Reject H_0

Table 6. Paired-Samples *t*-Test for ALNAT Pretest and Posttest Scores (*N* = 90)

Variable	Mean	SD	<i>t</i> -value	<i>df</i>	<i>p</i> -value	Decision
ALNAT Pretest	27.73	7.36				
ALNAT Posttest	38.42	13.37	-7.017	89	< .001	Reject H_0

Table 7. Effect Sizes for Pretest–Posttest Changes in RMA and ALNAT Scores

Assessment	Mean difference	<i>t</i>	<i>df</i>	Effect Size, <i>dz</i>	Interpretation
RMA	4.80	-3.39	89	0.36	Small to moderate
ALNAT	10.69	-7.02	89	0.74	Moderate to large

The effect-size results further indicate that the observed change was larger for ALNAT than for RMA. The RMA effect size, $dz = 0.36$, suggests a small to moderate increase, while the ALNAT effect size, $dz = 0.74$, suggests a moderate to large increase. This pattern supports the interpretation that students showed stronger gains in foundational and procedural mathematics skills than in higher-order reasoning-oriented performance.

However, these effect sizes must be interpreted cautiously. In a one-group pretest–posttest design, effect sizes describe the magnitude of change from pretest to posttest, but they do not prove that the instructional approach alone caused the change. Other influences, including regular curriculum exposure, student maturation, teacher familiarity, repeated testing, and general Grade 9 learning progression, may also have contributed to the observed improvement.

Interpreting the Stronger Gain in ALNAT

The alignment between structured problem-solving routines and foundational numeracy tasks may partly explain the stronger gain in ALNAT scores. The instructional approach used in this study emphasized guided modeling, step-by-step problem solving, scaffolded practice, collaborative board work, and repeated exposure to mathematical procedures. These routines are likely to support procedural fluency because they help students recognize patterns, follow solution sequences, and practice mathematical operations with guidance.

This interpretation is consistent with cognitive load theory, which suggests that instructional design can support learning when it reduces unnecessary processing demands and helps learners focus on essential task features (Sentz et al., 2019). It is also consistent with Ngu and Phan’s (2024) discussion of learning-by-comparison and cognitive-load-informed mathematics instruction, where worked examples and comparison of solution approaches can support the acquisition of mathematical proficiency.

At the same time, the results do not justify a strong causal conclusion. The observed gains occurred during a year in which structured problem-solving instruction was implemented. However, without a comparison group, the study cannot determine whether similar gains would have occurred through regular instruction alone. Therefore, the findings are best interpreted as evidence of improved performance during the implementation period, not as definitive proof of SPSI’s isolated effect.

Development of Reasoning and Problem-Solving Performance

The significant RMA gain suggests that students made measurable progress in mathematics performance involving reasoning and problem solving. However, the smaller effect size for RMA indicates that higher-order mathematical development was more limited than the improvement observed in foundational numeracy.

This pattern is theoretically plausible. Problem-solving theories emphasize that reasoning develops through repeated engagement with tasks requiring comprehension, planning, strategy selection, execution, and evaluation. Pólya's problem-solving framework highlights the importance of understanding the problem, devising a plan, carrying out the plan, and reviewing the solution. Metacognitive perspectives likewise emphasize monitoring and reflection during mathematical problem solving (Güner & Erbay, 2021). These processes are more demanding than procedural recall and may require longer and more targeted instructional support.

The rural learning context may also have shaped the pattern of results. Limited resources, interruptions due to weather disturbances, and varied learner readiness may constrain opportunities for sustained reasoning-focused instruction. Similar concerns have been raised in studies discussing resource limitations, flexible learning challenges, and contextual constraints in Philippine classrooms (Cortes, 2020; Malaluan et al., 2022; Baybayan & Cabanes, 2024). Thus, while the RMA gain is encouraging, it should be interpreted as gradual progress rather than strong evidence of fully developed reasoning proficiency.

Students' Perceptions of Structured Problem-Solving Instruction

Tables 8 to 11 summarize students' perceptions of structured problem-solving instruction across four domains: Interest and Participation in Mathematics, Difficulties in Solving Mathematics Problems, Effects of the Teaching Approach, and Classroom Support.

Students generally reported positive classroom experiences during the implementation of structured problem-solving instruction. The highest-rated items in the perception survey indicated that students believed step-by-step problem solving improved their understanding and that they were given enough time and guidance during problem-solving activities. These findings suggest that students positively received the instructional approach and may have supported classroom engagement, confidence, and perceived instructional support.

The positive ratings for classroom support are consistent with social constructivist and social learning perspectives, which emphasize the role of guided participation, teacher modeling, peer interaction, and scaffolded learning experiences. In mathematics classrooms, teacher guidance, worked examples, and collaborative problem solving can help students participate more actively and feel supported during complex tasks. Prior studies also suggest that student engagement, motivation, and self-efficacy are relevant to mathematics learning experiences (Etcuban et al., 2019; Mamolo, 2022; Mamolo & Sugano, 2023; Etcuban et al., 2024).

However, the perception data should be interpreted as evidence of acceptability and classroom experience, not as direct evidence that perceptions caused achievement gains. Students' responses show that they generally viewed the instructional approach positively, but additional statistical evidence is needed before concluding that these perceptions explain improvement in test scores.

Continuing Difficulties in Mathematical Problem Solving

Although students generally viewed the instructional approach positively, the perception results also showed that difficulties remained. Students reported needing more time to understand word problems, feeling nervous when solving problems in front of the class, and finding it difficult to explain solutions. These responses suggest that reasoning-intensive skills remained challenging even after exposure to structured problem-solving instruction.

This result is consistent with the RMA findings, where improvement was statistically significant but smaller than the ALNAT gain. Word problems and explanation tasks require more than procedural knowledge. They involve language comprehension, interpretation of given information, selection of appropriate strategies, and justification of answers. Such tasks may impose higher cognitive demands, especially for students with uneven foundational skills or limited confidence in mathematical communication.

Therefore, the perception results complement the achievement results by showing that structured instruction was positively received, while also indicating that students continued to experience difficulty with reasoning, explanation, and complex problem interpretation.

Table 8. *Descriptive Statistics for IPM (n = 49)*

Item	Mean	SD	Interpretation	Rank
Solving problems step by step improves my understanding.	4.5306	0.8441	Strongly Agree	1
Problem-solving activities help me understand mathematical concepts better.	4.0204	0.9680	Agree	2
I feel more confident when solving problems after repeated practice.	3.8571	0.9574	Agree	3
Explaining my answers helps me understand the lesson better.	3.7755	0.9846	Agree	4
I participate more actively during problem-solving activities.	3.6939	0.6833	Agree	5
Group work helps me learn different ways of solving problems.	3.6531	0.9254	Agree	6
I am more interested in Mathematics when lessons involve problem-solving activities.	3.6122	0.6395	Agree	7
I continue working on problems even when they are difficult.	3.47	0.767	Agree	8

Table 9. *Descriptive Statistics for DSMP (n = 49)*

Item	Mean	SD	Interpretation	Rank
I need more time to understand word problems.	3.9592	0.9565	Agree	1
I feel nervous when solving problems in front of the class.	3.7959	1.0202	Agree	2
I find it hard to explain my solution.	3.4694	0.9377	Agree	3
I get confused when problems contain too much information.	3.4694	0.9811	Agree	4
I struggle to identify the correct formula or operation.	3.3265	0.7743	Neutral	5
I find it difficult to understand the English used in math problems.	3.2245	1.0659	Neutral	6
Multi-step problems are difficult for me to solve.	3.1224	1.0131	Neutral	7

Table 10. *Descriptive Statistics for ETA (n = 49)*

Item	Mean	SD	Interpretation	Rank
The teaching approach helps me improve in solving problems.	4.0612	0.8758	Agree	1
Problem-solving activities help me in exams.	4.0000	0.8898	Agree	2
Repeated exposure to problem-solving improves my performance.	3.9388	1.0490	Agree	3
Real-life problems make lessons more meaningful.	3.7143	0.9129	Agree	4
Board work improves my reasoning skills.	3.5714	0.9789	Agree	5
Think-aloud discussions help me understand solutions.	3.5102	0.9381	Agree	6
I am more independent in solving problems now.	3.3265	0.8007	Neutral	7
I can solve problems better now than before.	3.1020	0.7704	Neutral	8

Table 11. *Descriptive Statistics for CS (n = 49)*

Item	Mean	SD	Interpretation	Rank
I am given enough time to solve problems.	4.2653	0.8361	Strongly Agree	1
My teacher provides enough guidance during problem solving.	4.1224	0.9494	Agree	2
I feel supported even when I make mistakes.	3.8776	0.8571	Agree	3
Examples in class help me solve similar problems.	3.7959	0.9785	Agree	4
My classmates help me understand the lesson.	3.6735	1.0080	Agree	5

High ratings in “Interest and Participation in Mathematics” suggest that students generally experienced structured problem-solving instruction as engaging and supportive. This pattern is consistent with social constructivist and social learning perspectives, which emphasize modeling, guided practice, and collaborative problem solving as supportive conditions for classroom participation. Ratings on “Effects of the Teaching Approach” and “Classroom Support” also indicate that students perceived teacher scaffolding, think-aloud demonstrations, and structured guidance as helpful features of the learning environment. Meanwhile, moderate scores in “Difficulties in Solving Mathematics Problems” suggest that students continued to experience challenges in interpreting word problems, selecting strategies, and explaining solutions. These difficulties are consistent with the gradual development of reasoning-intensive skills and with cognitive load theory, which suggests that complex mathematical tasks may impose high intrinsic load, particularly for students with uneven foundational knowledge. Previous studies likewise support the use of modeling, scaffolded guidance, collaborative problem solving, and teacher support as instructional conditions associated with engagement and mathematics learning (Etcuban et al., 2019; Etcuban et al., 2024; Mamolo, 2022). Self-efficacy and motivation have also been identified as relevant factors in mathematics achievement, supporting the relevance of social cognitive perspectives in Philippine mathematics education contexts (Mamolo & Sugano, 2023; Lu et al., 2022).

Relationship Between Perceptions and Achievement Gains

Tables 12–15 present descriptive statistics, correlations, and regression analyses linking perceptions to RMA and ALNAT gains.

Table 12. Descriptive Statistics

	<i>n</i>	Minimum	Maximum	Mean	Std. Deviation
IPM_Mean	49	1.88	4.75	3.8265	.55306
DSMP_Mean	49	2.00	4.86	3.4820	.66674
ETA_Mean	49	2.00	4.63	3.6551	.60809
CS_Mean	49	2.00	5.00	3.9469	.66680
RMA_Pretest	49	2.90	63.62	20.6657	11.41536
RMA_Posttest	49	2.90	62.32	24.2814	15.77812
ALNAT_Pretest	49	12.00	52.00	28.8571	8.35663
ALNAT_Posttest	49	18.00	64.00	37.5510	13.10385
Valid N (Listwise)	49				

Table 13. Correlations RMA-ALNAT Gains and Perceptions to SPSI

		RMA Gain	ALNAT Gain	IPM_ Mean	DSMP Mean	ETA Mean	CS Mean
RMA Gain	Pearson Correlation	1	-.115	.206	.257	.105	.189
	Sig. (2-tailed)		.432	.155	.075	.472	.194
	N	49	49	49	49	49	49
ALNAT Gain	Pearson Correlation	-.115	1	-.047	-.039	-.071	-.140
	Sig. (2-tailed)	.432		.747	.790	.629	.338
	N	49	49	49	49	49	49
IPM_Mean	Pearson Correlation	.206	-.047	1	.662**	.832**	.634**
	Sig. (2-tailed)	.155	.747		< .001	< .001	< .001
	N	49	49	49	49	49	49
DSMP_Mean	Pearson Correlation	.257	-.039	.662**	1	.569**	.556**
	Sig. (2-tailed)	.075	.790	< .001		< .001	< .001
	N	49	49	49	49	49	49
ETA_Mean	Pearson Correlation	.105	-.071	.832**	.569**	1	.738**
	Sig. (2-tailed)	.472	.629	< .001	< .001		< .001
	N	49	49	49	49	49	49
CS_Mean	Pearson Correlation	.189	-.140	.634**	.556**	.738**	1
	Sig. (2-tailed)	.194	.338	< .001	< .001	< .001	
	N	49	49	49	49	49	49

** . Correlation is significant at the 0.01 level (2-tailed).

Table 14. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.313 ^a	.098	.016	13.44610

Table 15. Coefficients^a

Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i>	Sig.	Collinearity Statistics	
	<i>B</i>	Std. Error	<i>Beta</i>			Tolerance	VIF
(Constant)	-19.830	14.162		-1.400	.168		
1	IPM_Mean	6.448	.263	.927	.359	.254	3.931
	DSMP_Mean	3.710	.182	.925	.360	.527	1.898
	ETA_Mean	-7.771	-.349	-1.173	.247	.232	4.305
	CS_Mean	3.612	.178	.811	.422	.427	2.340

a. Dependent Variable: RMA_GAIN

Correlation and regression analyses indicate that perception variables – interest and participation in mathematics, difficulties in solving mathematics problems, perceived effects of the teaching approach, and classroom support – were internally coherent but did not significantly predict achievement gains in this sample. Although positive perceptions may support motivation, engagement, and classroom participation, the present findings indicate that they did not automatically translate into measurable gains on the RMA or ALNAT. This interpretation is consistent with Brisson et al. (2020), who showed that students' responsiveness to classroom-based motivational interventions may vary according to individual differences and baseline characteristics. Environmental and contextual factors may also have limited the extent to which positive perceptions were reflected in standardized

assessment gains. Similarly, previous studies suggest that perceptions and motivational beliefs are often associated with engagement, enjoyment, and perceived value, but they do not always produce immediate or direct gains in achievement outcomes, particularly in short-term or constrained learning contexts (Brisson et al., 2020; Živković et al., 2023).

Contributions and Contextual Insights

This study provides classroom-based evidence from a rural Philippine coastal setting, showing that students' mathematics scores increased during the academic year in which structured problem-solving instruction was implemented. The larger observed gain in ALNAT than in RMA suggests stronger improvement in foundational and procedural skills than in reasoning-oriented performance. This pattern is consistent with literature suggesting that structured routines, guided examples, repeated practice, and scaffolded instruction may support procedural learning, while reasoning-intensive skills usually require more sustained development (Dimarucot, 2022; Arifin et al., 2020; Abiog, 2024). At the same time, the weak and non-significant relationships between perception variables and achievement gains highlight the complexity of learning in low-resource contexts, where motivation, engagement, and perceived support may not directly translate into measurable cognitive gains (Norman, 2023; Simmons & Sanders, 2022). These findings are consistent with Philippine studies indicating that structured instructional approaches may be useful in supporting mathematics learning, particularly when they are contextualized, carefully scaffolded, and responsive to learner readiness and environmental constraints.

Educational Implications

The findings suggest that structured problem-solving instruction may be a practical and low-cost instructional approach for rural, multi-ability mathematics classrooms. Its use of stepwise modeling, guided practice, think-aloud strategies, collaborative work, and scaffolded problem solving is consistent with studies emphasizing the value of scaffolding and metacognitive support in learning (Vo et al., 2025; Safa & Motaghi, 2021; Exintaris et al., 2023; Wu et al., 2025). Empirical and synthesis evidence also suggests that scaffolded problem-solving, when paired with metacognitive supports, can support students' attitudes toward mathematics, self-regulation, and conceptual understanding across STEM contexts (Vo et al., 2024; Sana & Fenesi, 2025). However, sustained implementation requires careful scaffold fading and alignment with higher-order thinking goals; explicit strategy instruction, reflective practice, and gradual release of teacher support are necessary to avoid overdependence on teacher guidance (Ajani, 2024). Infrastructure reliability, disaster preparedness, and post-pandemic learning recovery also remain important considerations, particularly in rural Philippine settings where intermittent power, class disruptions, and environmental constraints may limit consistent exposure to instruction (Adonis, 2020; Santos & Boyon, 2020). In practice, schools may consider developing SPSI-based lessons or unit banks that include worked examples, think-aloud prompts, guided practice tasks, metacognitive questions, and scaffold-fading plans. Low-cost, paper-based materials and teacher professional development in scaffolding and metacognition may support implementation without requiring high-end technology (Vo et al., 2025). Incorporating local culture and disaster-aware contexts may also help maintain relevance and continuity in the Bicol Region (Adonis, 2020; Santos & Boyon, 2020). Overall, the findings suggest that SPSI is a promising instructional approach. However, stronger research designs are needed before firm causal claims can be made about its independent effect on mathematics achievement.

Limitations

This study has several limitations. First, the one-group pretest-posttest design does not allow strong causal conclusions because no comparison or control group was included. Therefore, the observed gains cannot be attributed solely to structured problem-solving instruction. Other factors, such as regular curriculum exposure, student maturation, teacher familiarity, repeated testing, and broader school conditions, may have contributed to the score increases. Second, the study was conducted in one public secondary school, which limits the generalizability of the findings to other contexts. Third, the instruction was delivered by the teacher-researcher, which may have introduced implementation or expectancy effects. Fourth, the same RMA and ALNAT forms were used for pretest and posttest; therefore, test familiarity may have influenced students' posttest performance. Fifth, only 49 students had complete matched data for the perception, correlation, and regression analyses, and no statistical comparison was conducted between students with complete and incomplete perception data. Possible missing-data bias, therefore, cannot be ruled out. Finally, gain-score analysis was used without controlling for baseline performance; future studies may use ANCOVA-type or repeated-measures models with comparison groups to better isolate the contribution of SPSI to mathematics achievement.

Conclusion

This study contributes classroom-based evidence on Grade 9 mathematics achievement during the implementation of structured problem-solving instruction in a rural, resource-constrained, and disruption-prone school context. The observed gains in both RMA and ALNAT scores suggest that students' mathematics performance increased over the academic year, with stronger improvement in foundational and procedural skills than in reasoning-oriented performance. However, because the study used a one-group pretest-posttest design without a comparison group, these gains should be interpreted as changes observed during SPSI implementation rather than as conclusive evidence that SPSI alone caused the improvement.

The perception survey results indicate that students generally viewed the instructional approach and classroom support positively. These findings suggest that SPSI was acceptable and supportive from the learners' perspective. However, the correlation and regression analyses showed that perception variables did not significantly predict achievement gains. Thus, students' positive perceptions should be interpreted as evidence of classroom experience and engagement, not as statistical evidence explaining the observed score increases.

These findings carry several implications. In practice, teachers in similar rural or coastal contexts may consider using structured problem-solving routines to provide learners with clear, scaffolded support for mathematical tasks. At the policy and school-leadership levels, professional development may focus on structured routines, reasoning-oriented tasks, scaffolded instruction, and accessible strategies for multi-ability classrooms. For curriculum and instruction, the results suggest integrating metacognitive prompts, mathematical language support, and reading comprehension strategies into problem-solving activities. Future research should examine longer-term SPSI implementation using comparison groups, stronger quasi-experimental designs, ANCOVA-type analyses controlling for pretest scores, or repeated-measures models to better isolate the contribution of SPSI to student achievement.

Overall, this study provides practical insight into the use of structured problem-solving instruction in an authentic rural classroom setting. It suggests that SPSI is a promising approach for supporting mathematics learning. However, stronger research designs are needed before firm causal conclusions can be made about its independent effect on achievement.

Contributions of Authors

Author: conceptualization, data gathering, data analysis, proposal writing

Funding

The author received no financial support from any organization or funding agency for the research, authorship, and/or publication of this article. This study was entirely self-funded by the author.

Conflict of Interests

The author declares no conflict of interest regarding the publication of this paper.

Acknowledgment

The author would like to express his deepest gratitude and appreciation to the following individuals who contributed to the realization and success of this study. First and foremost, he is sincerely grateful to the late Raymundo Cantonjos, former Schools Division Superintendent, and the OIC-SDS/ Assistant SDS, Mr. Joel E. Caolboy, for the official approval and for allowing him to conduct this research within the division. His heartfelt thanks also go to my School Principal, Randy Emmanuel V. Bulanon and Assistant Principal Dr. Ofelia A. Mamforte, for their unwavering support, encouragement, and for providing a conducive environment for this research. He is equally indebted to his Head Teacher for the Math Department, Mrs. Emily H. Bultron, for the continuous guidance, supervision, and valuable insights throughout the process of writing this manuscript. Special recognition is also extended to his colleague, Mr. Junan Romero, and to the graduate school dean, Dr. Jonald Sia, for their professional support, shared expertise, and the time they generously extended to help him complete this study. Finally, my utmost gratitude goes to all the participants of the study for their cooperation, honesty, and willingness to answer the research instruments, as this work would not have been completed without them.

References

- Adonis, A. (2020). Contextualized strategic intervention materials in Grade 9 mathematics. *People International Journal of Social Sciences*, 5(3), 850–868. <https://doi.org/10.20319/pijss.2020.53.850868>
- Agbata, B.C., Obeng-Denteh, W., Kwabi, P.A., Abraham, S., Okpako, S.O., Arivi, S.S., ... & Adu Gyamfi, W.K. (2024). Everyday uses of mathematics and the roles of a mathematics teacher. *Science World Journal*, 19(3), 819–827. <https://scienceworldjournal.org/article/view/24035>
- Ajani, O. (2024). Enhancing problem-solving skills among pre-service teachers in higher education: A systematic literature review. *Journal of Pedagogical Sociology and Psychology*. <https://doi.org/10.33902/jppsp.202424002>
- Aquino, J., Barong, K., Sapotalo, R., & Panerio, S., Jr. (2025). Exploring disparities of mathematics education: A comparative study of challenges faced by rural and urban educational settings in Digos City. ResearchGate. <https://www.researchgate.net/publication/393424313>
- Baybayan, J., & Cabanes, A. (2024). Flipped classroom: Effect on the academic performance and motivation of Grade 8 students in mathematics. *International Journal of Multidisciplinary Applied Business and Education Research*, 5(4), 1304–1330. <https://doi.org/10.11594/ijmaber.05.04.17>
- Brisson, B., Hulleman, C., Häfner, I., Gaspard, H., Flunger, B., Dicke, A., ... & Nagengast, B. (2020). Who sticks to the instructions – and does it matter? Antecedents and effects of students'

- responsiveness to a classroom-based motivation intervention. *Zeitschrift Für Erziehungswissenschaft*, 23(1), 121–144. <https://doi.org/10.1007/s11618-019-00922-z>
- Caraan, D.R., Dinglasan, J.K., & Ching, D. (2022). "Realistic mathematics education approach on improving problem-solving skills of students." *The Research Probe*, 2(2), pp. 88–96. <https://tinyurl.com/yf4kwcw7>
- Chen, D., Zhang, Y., Luo, H., Gao, Z., Yu, L., & Lin, Y. (2025). Exploring the impact of scaffolding in programming on students' computational thinking: Evidence from a three-level meta-analysis. *Journal of Educational Computing Research*, 64(1), 208–237. <https://doi.org/10.1177/07356331251386618>
- Cortes, S. (2020). Flexible learning as an instructional modality in environmental science course during COVID-19. *Aquademia*, 4(2), ep20024. <https://doi.org/10.29333/aquademia/8444>
- Dorimana, A., Uworwabaye, A., & Nizeyimana, G. (2022). Enhancing upper secondary learners' problem-solving abilities using problem-based learning in mathematics. *International Journal of Learning Teaching and Educational Research*, 21(8), 235–252. <https://doi.org/10.26803/ijlter.21.8.14>
- Endlich, D., Lenhard, W., Marx, P., & Richter, T. (2023). Differential switch costs in typically achieving children and children with mathematical difficulties. *Journal of Learning Disabilities*, 57(4), 255–271. <https://doi.org/10.1177/00222194231204619>
- Etcuban, J., Mendoza, M., Catalan, J., & Ruiz, K. (2024). Academic performance and attitudes toward mathematics challenge of junior high school students. *British Journal of Teacher Education and Pedagogy*, 3(1), 58–73. <https://doi.org/10.32996/bjtep.2024.3.1.6>
- Etcuban, J., Peteros, E., Columba, D., Almerino, P., & Almerino, J. (2019). Attitude and academic achievement of high school students in mathematics under the conditional cash transfer program. *International Electronic Journal of Mathematics Education*, 14(3). <https://doi.org/10.29333/iejme/5770>
- Exintaris, B., Karunaratne, N., & Yuriev, E. (2023). Metacognition and critical thinking: Using ChatGPT-generated responses as prompts for critique in a problem-solving workshop (SMARTCHEMPer). *Journal of Chemical Education*, 100(8), 2972–2980. <https://doi.org/10.1021/acs.jchemed.3c00481>
- Güner, P., & Erbay, H.N. (2021). Metacognitive skills and problem-solving. *International Journal of Research in Education and Science*, 7(3), 715–734. <https://eric.ed.gov/?id=EJ1308166>
- Jahudin, J., & Siew, N. (2023). Infusion of Polya and digital bar model: An algebraic thinking module for seventh graders. *Problems of Education in the 21st Century*, 81(4), 481–500. <https://doi.org/10.33225/pec/23.81.481>
- Kadir, K. (2023). Students' mathematics achievement based on performance assessment through problem solving-posing and metacognition level. *Mathematics Teaching Research Journal*, 15(3), 109–135. <https://eric.ed.gov/?id=EJ1408243>
- Kareem, J., Thomas, R., & Nandini, V. (2022). A conceptual model of teaching efficacy and beliefs, teaching outcome expectancy, student technology use, student engagement, and 21st-century learning attitudes: A STEM education study. *Interdisciplinary Journal of Environmental and Science Education*, 18(4), e2282. <https://doi.org/10.21601/ijese/12025>
- Khair, I. (2022). Realities and impacts of teaching approach and method in bilingual classroom in Indonesia. *Parole Journal of Linguistics and Education*, 12(1), 103–118. <https://doi.org/10.14710/parole.v12i1.103-118>
- Koponen, T., Aunola, K., & Nurmi, J. (2019). Verbal counting skill predicts later math performance and difficulties in middle school. *Contemporary Educational Psychology*, 59, 101803. <https://doi.org/10.1016/j.cedpsych.2019.101803>
- Lindström-Sandahl, H., Samuelsson, J., Danielsson, H., Samuelsson, S., & Elwér, Å. (2024). A randomized controlled study of a second grade numeracy intervention with Swedish students at-risk of mathematics difficulties. *British Journal of Educational Psychology*, 94(4), 1052–1071. <https://doi.org/10.1111/bjep.12705>
- Lu, H., Chen, X., & Qi, C. (2022). Which is more predictive: Domain- or task-specific self-efficacy in teaching and outcomes? *British Journal of Educational Psychology*, 93(1), 283–298. <https://doi.org/10.1111/bjep.12554>
- Lucas, C. (2022). A Glimpse of Project NumerALS Journey: SESSION 5: Knowing and understanding the numeracy assessment tools: Rationale, framework and features DepEd Region. <https://tinyurl.com/55bvfec3>
- Malaluan, L., Espinosa, A., & Duad, V. (2022). Manifestations of environmental principles in bridging scientific context, reasoning and behaviour: Framework in the development of environmental education programmes in the Philippines. *Australian Journal of Environmental Education*, 39(2), 199–212. <https://doi.org/10.1017/ae.2022.49>
- Mamolo, L. (2022). Online learning and students' mathematics motivation, self-efficacy, and anxiety in the "new normal". *Education Research International*, 2022, 1–10. <https://doi.org/10.1155/2022/9439634>
- Mamolo, L., & Sugano, S. (2023). Digital interactive app and students' mathematics self-efficacy, anxiety, and achievement in the "new normal". *E-Learning and Digital Media*, 21(5), 427–443. <https://doi.org/10.1177/20427530231167646>
- Manouchehri, A., & Sriraman, B. (2020). Mathematical cognition: In secondary years [13–18] part 2. In: Lerman, S. (eds) *Encyclopedia of Mathematics Education*. Springer, Cham. https://doi.org/10.1007/978-3-030-15789-0_100039
- Ngu, B., & Phan, H. (2024). Instructional approach and acquisition of mathematical proficiency: Theoretical insights from learning by comparison and cognitive load theory. *Asian Journal for Mathematics Education*, 3(3), 357–379. <https://doi.org/10.1177/27527263241266765>
- Nhan, L.K. (2024). Enhancing teaching and learning through formative assessment. *International Journal of Science and Management Studies*, 7(3), 356–365. <https://tinyurl.com/599u7f7t>
- OECD. (2023). PISA 2022 Results (Volume III) - Factsheets: Philippines. OECD. <https://tinyurl.com/4utfabiv>
- Padayon UP. (2023). UP NISMED develops rapid mathematics assessment toolkits for DepEd's National Mathematics Program. Padayon UP. <https://publicservice.up.edu.ph/news-3/>
- Rojo, M., Gersib, J., & Powell, S. (2024). A meta-analysis of mathematics interventions: Examining the impacts of intervention characteristics. *Educational Psychology Review* 36, 9 (2024). <https://doi.org/10.1007/s10648-023-09843-0>
- Roorda, G., de Vries, S., & Smale-Jacobse, A. (2024). Using lesson study to help mathematics teachers enhance students' problem-solving skills through problem-solving teaching. In *Frontiers in Education* (Vol. 9, p. 1331674). Frontiers Media SA. <https://tinyurl.com/99ajy595>
- Ruzek, E., Aldrup, K., & Lüdtke, O. (2022). Assessing the effects of student perceptions of instructional quality: A cross-subject within-student design. *Contemporary Educational Psychology*. <https://doi.org/10.1016/j.cedpsych.2022.102085>
- Safa, M., & Motaghi, F. (2021). Cognitive vs. metacognitive scaffolding strategies and EFL learners' listening comprehension development. *Language Teaching Research*, 28(3), 987–1010. <https://doi.org/10.1177/13621688211021821>
- Sana, F., & Fenesi, B. (2025). Working memory and instructional fit: Reintroducing aptitude-treatment interaction in education research. *Behavioral Sciences*, 15(6), 765. <https://doi.org/10.3390/bs15060765>
- Santos, J., & Boyon, M. (2020). Effect of inquiry-based lessons on STEM students' learning competencies on limits and continuity. *People International Journal of Social Sciences*, 5(3), 782–792. <https://doi.org/10.20319/pijs.2020.53.782792>
- Santos, K.C., Cagasan, L., Jr., Loberiza, K.B., Tenorio, A., Angeles, A.J., & Lapitan, M.A. (2025). Examining the DepEd's national assessments: A review of framework, design, development, psychometric properties, and utilization (Discussion Paper Series No. 2025-25). Philippine Institute for Development Studies. <https://tinyurl.com/y8vxxkhrz>
- Sentz, J., Stefaniak, J., & Baaki, J. (2019). How do instructional designers manage learners' cognitive load? An examination of awareness and application of strategies. *Educational Technology Research and Development*, 67, 199–245. <https://doi.org/10.1007/s11423-018-09640-5>
- Tuazon, A.C. (2024). Climate-proof learning. *Philippine Daily Inquirer*. <https://tinyurl.com/2s7kht4b>
- UP NISMED. (2023). UP NISMED takes part in DepEd's National Mathematics Program.
- Vo, K., Sarkar, M., White, P., & Yuriev, E. (2025). Exploring problem-solving scaffolds in general chemistry: A systematic review of scaffolding goals and instructional approaches. *Journal of Chemical Education*, 102(3), 1004–1018. <https://doi.org/10.1021/acs.jchemed.4c01327>
- Ward, E. (2024). Seven-year itch: Sustaining and scaling a cognitively guided instruction initiative. <https://doi.org/10.3102/ip.24.2110280>
- Wu, T., Lee, H., Chen, P., Wang, W., & Huang, Y. (2025). Integrating computational thinking diagnostic mechanism and reflective learning: An innovative approach to enhance learning outcomes in introductory programming. *Journal of Computer Assisted Learning*, 41(5). <https://doi.org/10.1111/jcal.70121>
- Xu, E., Wang, W., & Wang, Q. (2023). The effectiveness of collaborative problem solving in promoting students' critical thinking: A meta-analysis based on empirical literature. *Humanities and Social Sciences Communications*, 10(1). <https://doi.org/10.1057/s41599-023-01508-1>
- Yang, X., Yan, M., Ruan, Y., Ku, S., Lo, J., Peng, P., ... & McBride, C. (2022). Relations among phonological processing skills and mathematics in children: A meta-analysis. *Journal of Educational Psychology*, 114(2), 289–307. <https://doi.org/10.1037/edu0000710>
- Živković, M., Pellizzoni, S., Doz, E., Cuder, A., Mammarella, L., & Passolunghi, M. (2023). Math self-efficacy or anxiety? The role of emotional and motivational contribution in math performance. *Social Psychology of Education*, 26(3), 579–601. <https://doi.org/10.1007/s11218-023-09760-8>