

DEVELOPING PROBLEM-SOLVING SKILLS AMONG GRADE 9 STUDENTS OF PILA DISTRICT DIVISION OF LAGUNA THROUGH MATH SCENE INVESTIGATOR (MSI) COGNITIVE STRATEGY

Christopher G. Elona, Allen E. Pasia, MA^b

^a christopher.elona@deped.gov.ph

^a Teacher II, Linga National High School Linga, Pila, Laguna

^b Associate Professor College of Teacher Education, Laguna State Polytechnic University, San Pablo City, Laguna 4000 Philippines

Abstract

The study determined whether Math Scene Investigator (MSI) Cognitive Strategy could lead to measurable improvement in students' problem-solving skills through assessment of students' performance before and after implementing the strategy. The experimental group consisted of Grade 9 students from public high school in the School District of Pila, Province of Laguna. The primary instrument used was a validated researcher-made test that consisted of four problem solving tasks with guide questions.

Results showed improvement in problem-solving skills of Grade 9 students in terms of Frequency and Variety of Approaches from Good to Excellent, and improvement in problem-solving skills of Grade 9 students from Poor to Very Good in terms of both Degree that Approaches are Pursued and Success/Correct Answer.

The significant difference between the mean post-test score after utilization of Math Scene Investigator (MSI) Cognitive Strategy and the mean pre-test score of Grade 9 students before utilization of Math Scene Investigator (MSI) Cognitive Strategy support claim of the effectiveness of the utilization of Math Scene Investigator (MSI) Cognitive Strategy in enhancing, or improving, the problem solving skills of students in terms of Frequency and Variety of Approaches, Degree that Approaches are Pursued, and Success/Correct Answer. Mathematics teachers were encouraged to integrate the MSI Cognitive Strategy into regular instruction, especially when teaching word problems. Focus should be placed on helping students understand problems, identify key word clues, plan effectively, and check their answers.

Keywords: *Problem-solving skills, cognitive strategy, math scene investigator*

Introduction

Findings in 2022 of Programme for International Student Assessment (PISA) showed Filipino students ranked near the bottom with average score of 355 points, which was significantly lower than the average of 472 points based on the Organization for Economic Cooperation and Development (OECD) data. Also, 16% of Filipino students reached level II of proficiency in Mathematics, which was significantly lower than the average proficiency in Mathematics of 69% based on the OECD data.

Recent 2019 database of Trends in International Mathematics and Science Study (TIMSS), showed Filipino learners with score of 297 points, which was the lowest out of fifty-eight (58) countries that participated in the study. Moreover, 297 points represented a decline from the score of 358 in Mathematics in the 2003 study by TIMSS.

To address the poor performance in Mathematics of Filipino learners, the Department of

Education (DepEd) encouraged Mathematics teachers to employ the use of instructional strategies that would better develop and improve the mathematical skills of learners. This measure was the message of DepEd Order Number 17, series of 2022. Project Climb and Learn, which used fairy tales to teach mathematical operations to pupils, was one of the initiatives taken by the DepEd.

By DepEd Order Number 013, series of 2023, the Department of Education launched the National Learning Recovery Program (NLRP), whose aim was to raise the level of achievement of learners in numeracy and literacy. The DepEd provided teachers with strategies that were expected to help learners having difficulty in Mathematics. Some of these strategies were peer-assisted instruction, differentiated instruction, ongoing formative assessment, the use of visual representations of functions and relationships, and systematic and explicit instruction.

The researcher investigated one of the instructional strategies that mathematics teachers utilized to teach problem-solving, the Math Scene Investigator (MSI) Cognitive Strategy. When utilized to some extent, this strategy helped students develop problem-solving skills. Thus, the researcher likewise determined the extent of utilization of Math Scene Investigator (MSI) Cognitive Strategy in the teaching of problem-solving.

Statement of the Problem

The study's main objective was to investigate how the use of the Math Scene Investigator (MSI) Cognitive Strategy supported the development of problem-solving skills among Grade 9 students from the Pila District, Division of Laguna. Specifically, the study sought to determine the effectiveness of the MSI strategy by examining students' performance before and after its implementation.

1. What is the level of problem-solving skills of Grade 9 students as determined by pre-test before using the Math Scene Investigator (MSI) Cognitive Strategy and by the post-test after using the Math Scene Investigator (MSI) Cognitive Strategy in terms of:

- 1.1 Frequency and Variety of Approaches;
- 1.2 Degree that Approaches are Pursued; and
- 1.3 Success/Correct Answer?

2. What is the difference between the level of problem-solving skills of Grade 9 students before using the Math Scene Investigator (MSI) Cognitive Strategy as determined by pre-test and the level of problem-solving skills of Grade 9 students after using the Math Scene Investigator (MSI) Cognitive Strategy as determined by post-test in terms of:

- 2.1 Frequency and Variety of Approaches;
- 2.2 Degree that Approaches are Pursued; and
- 2.3 Success/Correct Answer?

3. Is there significant difference in the level of problem-solving skills of Grade 9 students before and after using the Math Scene Investigator (MSI) Cognitive Strategy as determined by pre-test and post-test?

Methodology

The experimental research design was used to attain the study's objectives. The researcher implemented the MSI Cognitive Strategy in teaching problem-solving to Grade 9 students. To assess the improvement in students' problem-solving skills, the researcher employed a structured intervention and evaluated student performance before and after implementing the strategy. Use of pre-test and post-test to assess changes in student performance facilitated comparison between students' levels of problem-solving skills before and after the intervention.

The participants of this study consisted of a single group of Grade 9 students from a public high

school located in the School District of Pila, Province of Laguna. These students served as the experimental group for the study, and no control group was utilized. The selection was conducted through a stratified sampling technique where the group of Grade 9 students was divided into subgroups/strata. The population size for the study was the sum of the numbers of Grade 9 students in the four (4) groups. Sample size from each strata was obtained by ratio and proportion.

The researcher prepared a lesson plan focused on problem-solving in the four types of variation, integrating the Math Scene Investigator (MSI) Cognitive Strategy. A teacher-made pre-test was also prepared, consisting of two (2) problems per type of variation, with students being allotted forty-five (45) minutes to solve the problems specifically related to inverse variation.

After both tests were administered, the researcher collected and recorded the pre- and post-test scores of the fifty student-participants. These scores were used to evaluate the level of problem-solving skills before and after the use of the MSI Cognitive Strategy. The data also helped determine whether a significant difference existed in student performance following the intervention. Mean, standard deviation, frequency and percentage were utilized to consolidate the respondents' assessment of the teacher's performance.

Results and Discussion

Table 1

Overall Performance of Grade 9 Students in Pre-Test in Solving Word Problems in Mathematics

Problem Solving Skills	Mean	Standard Deviation	Verbal Interpretation
Frequency and Variety Approaches	76.98	5.40	Good
Degree that Approaches are Pursued	74.00	4.58	Poor
Success/ Correct Answer	73.82	4.79	Poor
Total Score	74.92	4.71	Poor

Students performed best in Frequency and Variety of Approaches, with a mean score of 76.98 and a verbal interpretation of Good. In contrast, lower scores were observed in the Degree that Approaches are Pursued ($M = 74.00$) and Success/Correct Answer ($M = 73.82$), both interpreted as Poor. The overall total mean score across all dimensions was 74.92, also falling within the Poor category, with a standard deviation of 4.71, reflecting moderate variation in student performance. Generally, Grade 9 students have problems with problem-solving skills. That is, they could not really solve Mathematics problem since they could not proceed with the process of problem-solving beyond the first step in terms of Frequency and Variety of Approaches.

Table 2

Overall Performance of Grade 9 Students in Post-Test in Solving Word Problems in Mathematics

Problem Solving Skills	Mean	Standard Deviation	Verbal Interpretation
Frequency and Variety Approaches	97.30	3.94	Excellent
Degree that Approaches are Pursued	94.16	6.78	Very Good
Success/ Correct Answer	78.10	8.75	Good
Total Score	89.90	5.34	Very Good

Highest mean score was observed in Frequency and Variety of Approaches ($M = 97.30$, $SD = 3.94$), interpreted as Excellent. This was followed by a Very Good rating in the Degree that Approaches

are Pursued ($M = 94.16$, $SD = 6.78$) and a Good rating in Success/Correct Answer ($M = 78.10$, $SD = 8.75$). The overall total mean score was 89.90, with a standard deviation of 5.34, indicating a Very Good level of problem-solving performance after the intervention. In general, utilization of Math Scene Investigator (MSI) Cognitive Strategy improved the problem-solving skills of Grade 9 students from Poor to Very Good. This implies that the use of Math Scene Investigator (MSI) Cognitive Strategy was effective in improving the problem-solving skills of Grade 9 students in the three (3) phases of the process of problem-solving, namely, Frequency and Variety of Approaches, Degree that Approaches are Pursued, and Success/Correct Answer.

Table 3**Test of Difference between the Pre-Test and Post-Test Scores in Problem-Solving Skills**

Problem-Solving Skills	Pre-test		Post-test		t-value	df	p-value	Interpretation
	Mean	SD	Mean	SD				
Frequency	76.98	5.40	97.30	3.94	20.62	49.00	.000	Significant
Degree	74.00	4.58	94.16	6.78	21.83	49.00	.000	Significant
Success	73.82	4.79	78.10	8.75	3.58	49.00	.000	Significant
Over All	74.92	4.71	89.90	5.34	18.59	49.00	.000	Significant

Level of Significance = 0.05 | Test Statistic = Dependent t-test

Findings indicate significant improvements across all measured domains. The p-values for all indicators were less than the significance level ($\alpha = 0.05$), leading to the rejection of the null hypothesis, which stated that there is no significant difference between pre-test and post-test scores. These results confirm that the implementation of the MSI Cognitive Strategy had positive and statistically significant effect on students' problem-solving performance. Results further confirmed the claim that utilization of Math Scene Investigator (MSI) Cognitive Strategy could enhance, or improve, the problem-solving skills of students.

Recommendations

Mathematics teachers are encouraged to integrate the MSI Cognitive Strategy into regular instruction, especially when teaching word problems. Focus should be placed on helping students understand problems, identify key word clues, plan effectively, and check their answers. School heads and Mathematics coordinators are encouraged to support teachers through capacity-building programs on MSI and similar strategies. They may also consider initiating collaborative efforts to develop shared instructional materials, such as a repository of word clues and sample problems. Curriculum developers and education policymakers may find value in incorporating MSI-based strategies into existing numeracy programs like DepEd's NLRP. These strategies offer strong potential in promoting both conceptual understanding and cognitive engagement in Mathematics. Future researchers are advised to replicate this study across different topics and grade levels. Exploring digital enhancements to MSI and examining long-term retention of skills will help assess its broader educational impact.

References:

- Anderson, W. 2024. Approaches to Mathematics Problem-solving. *American Journal of Teaching Mathematics*. 6(3), 77- 84.
- Belanger, F. 2021. Skills for Understanding Mathematics Problems. *International Journal of Mathematics Teachers for Quality Instruction*. Mahwah, New Jersey. Erlbaum. 11 (3), 122 – 131.
- Bermas, J. 2019. “Mathematical Challenges to Resistance at Risk students and their Problem Solving Skills.” Unpublished Master’s Thesis. Laguna State Polytechnic University, San Pablo City
- Buckley, J. 2021. Success Indicators of Plan Devised for Solving Mathematics Problems. *Series Guide*. Chicago: Educational and Mathematical Research Associates.
- Cloutier, E. 2024. Positive Correlates of Students’ Improved Performance in Mathematics Problem-solving. *International Journal of Mathematics Teachers for Quality Education*. Needham Heights, MA. Allyn and Bacon. 6 (3), 76 – 83.
- Crewell, W., & Creswell, D. 2022. *Research design: Qualitative, quantitative, and mixed methods approaches* (6th ed.). SAGE Publications.
- Cremer, S. 2022. *Mathematics Teachers in Action: Problem-Solving with Word Clues*. Minneapolis: University of Minnesota Press.
- Deakins, W. 2023. *Approaches to Problem Solving in Mathematics with Integration of Technology*. Baltimore, MD: Orton Mathematics Society.
- Eastmond, V. and Z. Griffin. 2022. *Problem-Solving in Mathematics; Emphasis on the Process*. Morristown, New Jersey: General Learning Press.
- Foster, S. 2021. *Problems of Students in Problem-solving*. Cardiff: Cardiff University for Mathematics Education Research Council.
- Gruber, M. 2021. *Teaching Problem-Solving in High School Mathematics*. Century. Lexington, Massachusetts: D. C. Heath.
- Hines, B. and L. Lockwell. 2022. *Differentiating Approaches to Problem-solving*. 2nd Edition. London: Tavistock.
- Hughes, R. 2020. *Teacher-made Mathematics Problems: Impact on Students’ Problem-solving Skills*. Los Angeles, CA: Mathematics Teachers Publications.
- Heinen, P. and R. Delamer. 2022. Significant Factors of Students’ Success in Mathematics Problem-solving. *Research Journal on Instructional Management and Technology*. 8(7), 54-67.
- Johnstone, A. 2024. *Measures to Address Difficulty of Students in Understanding Mathematics Problems*. Los Angeles, CA: Mathematics Publications.
- Kazlauskas, D. 2020, *Accuracy and Precision in Mathematics Problem-solving*. Hillside, New Jersey: Lawrence Erlbaum Associates.
- Korhonen, L. 2022. Today’s Challenges in Teaching Problem-solving in Mathematics. *Effective Instructional Management*. Alexandria, VA: Association of Mathematics Teachers. 37 (30), 137 – 141.
- Kritchevsky, J. and H. Ittleson. 2021. Advantages of Using Cognitive Strategies. R. Harris and F. Resnick (Eds.). New York: Marcel Dekker.
- Kolb, C. 2023. Utilization of Cognitive Strategy in Problem-solving. Paper presented Graduate Student Seminar in Teaching Mathematics.
- Lowenstein, G. 2023. On Cognitive Strategy for Mathematics Problem-solving. *Journal of Modern Teaching*. 5(3), 47-58.
- Lebrun, E. and B. Muller. 2024. *The Quality of Solution and Problem-Solving Skills of Students. A Study Funded by the Institute for Educational Development*. New Hampshire State University Press.

- Levesque, H. 2022. Application of Mathematical Skills in Problem-solving in Mathematics. San Rafael, CA: Mathematics Teachers Publications.
- Murphy, J. and N. Cameron. 2023. What Students to Understand when Solving Mathematics Problems. Washington, DC. Association for Quality Instruction in Mathematics and Science.
- McMillan, J. H. 2022. Educational research: Fundamentals for the consumer (8th ed.). Pearson Education.
- Medwell, C. and G. Askew. 2022. The Process of Problem-solving. 2nd Edition. New York: Elsevier.
- Murray, A. 2020. Problem Solving Skills in Different Learning Areas. 2nd Edition. L. Burgess and F. T. Miller, Editors. Syracuse, New York. Syracuse University Press.
- Pabilona, T. and C. Caparros. 2023. Strengths and Weaknesses of Students in Implementing the Plan for Solution of Mathematics Problems. Unpublished Research Paper for a Course in Master's Program.
- Puyod, L. 2022. Examining the Processes of Problem Solving Practiced by Selected Elementary Pupils. Unpublished Paper for a Program Requirement in the Graduate Level.
- Rapadas, S. and G. Buenaflor. 2021, Teaching Problem-Solving in Philippine Setting. Paper submitted as Course Requirement in Graduate Program.
- Rehm, M. 2013. Cognitive apprenticeship theory as a framework for teaching online design courses. International Journal of Technology and Design Education, 23(3), 537-548.
<https://doi.org/10.1007/s10798-011-9205-3>
- Scholzen, G. and W. Collard. 2023. Teaching Problem-Solving in Mathematics with Word Clues. Mathematics Teaching in Review. Greenwich, Connecticut: JAI Press.
- Schoenfeld, A. H. 2013. Reflections on problem solving theory and practice. The Mathematics Enthusiast, 10(1-2), 9-34. <https://scholarworks.umt.edu/tme/vol10/iss1/3>
- Schleifer, C. and F. Sackheim. 2022. Math Scene Investigator (MSI) Cognitive Strategy for Primary Levels. University of Nebraska: School of Mathematics Education.
- Stoffels, M. and D. Ebden. 2021. Pitfalls in Using Mathematics Word Clues. Journal of Research for Mathematics Teachers. 11(4), 67 -78.
- Swanson, H. L. 2014. Improving mathematical problem-solving for students with learning disabilities: A cognitive strategy instruction approach . Learning Disabilities Quarterly, 37(3), 133-143.
<https://doi.org/10.1177/0731948713507267>
- Thompson, W. 2023. Identifying the Difficulties of High School Students in Learning Problem-solving in Mathematics. Instructional Leaders in Mathematics Today. Portsmouth, NH: Heinemann. 45 (15), 7 – 18.
- Turner, T. and P. Poincare. 2021. Applying MSI Cognitive Strategy to Selected Mathematics Lessons. Chapel Hill: Caroline Mathematics Studies Center.
- Tremblay, P. 2023, Techniques and Skills for Analyzing Problems in Mathematics. New York, NY. Guilford Publications.
- Vandewalle, H. and T. Pauwels. 2020. Essential Problem-Solving Skills for All Learners. Mathematics Teachers Quarterly. 8(3), 71- 93.
- Weber, F. and A. Breuer. 2021, Helping the Anxious Problem-Solver. Journal of Applications of Mathematics. 7(6), 46-53.