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Assessing the Mathematical Proficiency and Critical Problem-Solving Capabilities of Key Stage 3 Students of SDO Iriga City

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ABSTRACT

This study assessed the mathematical proficiency and critical problem-solving capabilities of Key Stage 3 learners of the Schools Division Office of Iriga City during School Year 2025-2026 as a diagnostic basis for targeted instructional interventions. A quantitative descriptive-correlational research design was employed. The respondents were 378 Grade 7 to Grade 10 learners selected through stratified random sampling. Data were gathered using validated assessment instruments that measured learners' academic performance in Mathematics, their mathematical proficiency across conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition, and their critical problem-solving capabilities across problem interpretation, strategy formulation, execution and analysis, and evaluation and reflection. Descriptive statistics, one-way analysis of variance, and correlation analysis were used. Findings showed that most learners were classified under the Proficient (31.7%) and Approaching Proficiency (30.2%) levels based on preceding Mathematics grades. Learners demonstrated a high overall extent of mathematical proficiency (WM = 3.39), with procedural fluency obtaining the highest mean (WM = 3.56) and adaptive reasoning the lowest (WM = 3.21). They also demonstrated a high overall level of critical problem-solving capability (WM = 3.35), with execution and analysis obtaining the highest mean (WM = 3.53) and evaluation and reflection the lowest (WM = 3.17). Significant differences were found in mathematical proficiency and critical problem-solving capabilities when learners were grouped by grade level and preceding Mathematics grade. The study concludes that mathematical proficiency is closely associated with critical problem-solving capability and that interventions should strengthen reasoning, strategic competence, reflection, and differentiated mathematics support.

Keywords: *mathematical proficiency, critical problem-solving capabilities, Key Stage 3 learners, mathematics achievement, adaptive reasoning, procedural fluency*

INTRODUCTION

Mathematics is a fundamental discipline that supports logical reasoning, informed decision-making, and the solution of practical problems in everyday life. It serves as a universal language for understanding patterns, quantities, structures, and relationships. In school contexts, mathematics instruction is expected to develop not only computational accuracy but also reasoning, communication, representation, and critical problem-solving ability. Ariyanti and Santoso (2020) emphasized that mathematics equips learners with critical thinking and problem-solving skills that are necessary for academic and life success.

Despite the centrality of mathematics in education, Filipino learners continue to encounter difficulty in mathematical achievement. International and national assessments have shown persistent gaps in mathematics learning. The 2018 Programme for International Student Assessment results reported that only a small proportion of Filipino learners reached the minimum proficiency level in mathematics, while many performed below the expected level (Department of Education, 2019). Similarly, the 2022 National Achievement Test showed continuing concerns in Grade 10 mathematics proficiency (Department of Education, 2022). These results indicate a need for stronger, evidence-based mathematics interventions.

In the Schools Division Office of Iriga City, teachers observe similar challenges among Key Stage 3 learners. Many learners can follow procedures when a formula is already provided, but they experience difficulty when asked to interpret word problems, plan solution strategies, justify answers, or apply mathematics to unfamiliar situations. This reflects a gap between routine computation and independent mathematical problem solving. It also points to the need for diagnostic evidence that can guide contextualized instruction for Irigueño learners.

Mathematical proficiency provides a comprehensive lens for understanding learner competence because it includes conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition (Kilpatrick et al., 2001). Critical problem-solving capability complements this framework because it requires learners to interpret problems, formulate strategies, execute and analyze solutions, and evaluate or reflect on results. Together, these constructs provide a broader view of mathematical learning than grades or routine achievement tests alone.

This study assessed the mathematical proficiency and critical problem-solving capabilities of Key Stage 3 learners of SDO Iriga City during School Year 2025-2026. It examined learners' preceding Mathematics performance, determined their proficiency across the five strands, assessed their problem-solving capabilities across four cognitive phases, tested differences by grade level and preceding Mathematics grade, and examined the relationship between mathematical proficiency and critical problem-solving capability. The findings were intended to provide an empirical basis for targeted instructional interventions, differentiated learning support, and mathematics teacher development.

Literature Review

Mathematical Proficiency as a Comprehensive Learning Construct

Mathematical proficiency refers to a learner's integrated capacity to understand, use, reason with, and value mathematics. Kilpatrick et al. (2001) described mathematical proficiency through five interwoven strands: conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. These strands are not independent skills but mutually reinforcing dimensions of mathematical learning.

Conceptual understanding involves comprehension of mathematical ideas, principles, and relationships. Procedural fluency refers to the accurate, efficient, and flexible use of mathematical procedures. Strategic competence concerns the ability to formulate, represent, and solve mathematical problems. Adaptive reasoning involves logical explanation, justification, and evaluation of mathematical claims, while productive disposition reflects learners' belief that mathematics is useful and that they can succeed in learning it.

The literature suggests that students may show stronger performance in procedural tasks than in reasoning or strategic application. Yulian and Wahyudin (2018) analyzed categories of mathematical proficiency among junior high school learners and emphasized the need to examine proficiency in a holistic manner. Ho (2020) likewise highlighted the importance of integrating conceptual and procedural knowledge in mathematical problem solving.

Critical Problem-Solving Capability in Mathematics

Problem solving is a central goal of mathematics education. It requires learners to analyze unfamiliar situations, identify relevant information, plan solution strategies, carry out procedures, and verify whether the answer is reasonable. Polya's (1945) four-stage framework of understanding the problem, devising a plan, carrying out the plan, and looking back remains a foundational model in mathematics education.

Critical problem-solving capability extends beyond routine computation. It involves interpretation, strategy formulation, execution and analysis, and evaluation and reflection. These phases require higher-order thinking because learners must decide what information is relevant, choose an appropriate strategy, justify their process, and check alternative methods. The Organisation for Economic Co-operation and Development (n.d.) similarly views problem solving as the use of cognitive processes to understand and resolve situations where a solution is not immediately obvious.

Recent literature emphasizes the role of critical thinking in mathematical problem solving. Suryawan et al. (2023) reported that solving mathematical problems requires analysis, inference, evaluation, and reflection. These processes are closely linked with learners' ability to explain reasoning, communicate solutions, and transfer knowledge to real-life mathematical situations.

Relationship Between Mathematical Proficiency and Problem Solving

Mathematical proficiency and problem-solving capability are closely connected. Learners who possess strong conceptual understanding are better able to recognize relationships in mathematical situations, while learners with strong procedural fluency can perform operations accurately. Strategic competence directly supports planning and representation, while adaptive reasoning supports justification and evaluation of solutions.

Schoenfeld (1985) emphasized that successful mathematical problem solving depends not only on knowledge of procedures but also on control, strategy selection, and belief systems. This aligns with the five-strand model of mathematical proficiency because students need concepts, procedures, strategies, reasoning, and disposition to solve mathematical problems effectively.

In this study, mathematical proficiency was expected to be associated with critical problem-solving capability. Learners with higher proficiency were expected to show stronger ability to interpret, plan, execute, evaluate, and reflect on mathematical solutions. This relationship provides an important basis for designing intervention programs that strengthen both mathematical content and cognitive problem-solving processes.

Mathematics Education in the Philippine and Local Context

The Philippine K to 12 Mathematics Curriculum emphasizes critical thinking, problem solving, reasoning, communication, representation, and mathematical connections (Department of Education, 2016). These competencies align with international views of mathematics learning that go beyond memorization and routine computation. Key Stage 3 learners are expected to move toward more independent reasoning and problem solving as they progress across grade levels.

However, national assessment results suggest that many Filipino learners still struggle to demonstrate expected levels of mathematical proficiency (Department of Education, 2022). Such findings call for local studies that diagnose specific learner strengths and gaps. A division-level assessment is important because it can capture the realities of classrooms more directly than national data alone.

For SDO Iriga City, examining the mathematical proficiency and problem-solving capabilities of learners can help teachers and school leaders design responsive interventions. The local findings can support differentiated instruction, problem-solving-oriented activities, and professional development that address the actual performance patterns of Irigueño learners.

METHODS

Research Design

The study employed a quantitative descriptive-correlational research design. The descriptive component was used to determine learners' academic performance in Mathematics, the extent of their mathematical proficiency, and the level of their critical problem-solving capabilities. The correlational component was used to examine the relationship between mathematical proficiency and critical problem-solving capability. The design was appropriate because the study described existing learner conditions and tested relationships among variables without manipulating the learning environment.

Research Locale

The study was conducted in selected public secondary schools under the Schools Division Office of Iriga City. The locale was appropriate because the study focused on Key Stage 3 learners and sought to provide diagnostic evidence for mathematics instruction, supervision, and intervention planning in the division.

Participants and Sampling Technique

The respondents were 378 Key Stage 3 learners from Grades 7 to 10 during School Year 2025-2026. The distribution included 107 Grade 7 learners, 100 Grade 8 learners, 79 Grade 9 learners, and 92 Grade 10 learners. Stratified random sampling was employed to ensure adequate representation from each grade level.

Table 1. *Distribution of Respondents by Grade Level*

Grade level	Number of learners	Percentage
Grade 7	107	28.3%
Grade 8	100	26.5%
Grade 9	79	20.9%
Grade 10	92	24.3%
Total	378	100.0%

Research Instrument

Data were gathered using validated assessment instruments. The Mathematical Proficiency Assessment Instrument measured learners' proficiency across conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. The Critical Problem-Solving Capability Test measured learners' ability to interpret problems, formulate strategies, execute and analyze solutions, and evaluate or reflect on answers. The instruments were aligned with the Philippine K to 12 Mathematics Curriculum and relevant frameworks on mathematical proficiency and problem solving.

Data Gathering Procedure

The researchers secured permission from appropriate school and division authorities before data collection. The assessment instruments were administered to the selected KS3 learners under standardized conditions. Learners' preceding grade-level final grades in Mathematics were also gathered and categorized using the grade descriptions Advanced, Proficient, Approaching Proficiency, Developing, and Beginning. Completed responses were checked, encoded, and prepared for statistical analysis.

Data Analysis

Frequency and percentage were used to describe learners' preceding Mathematics performance. Weighted mean and standard deviation were used to determine the extent of mathematical proficiency and the level of critical problem-solving capability. One-way analysis of variance was used to determine whether significant differences existed when learners were grouped by grade level and preceding Mathematics grade. Correlation analysis was used to determine the relationship between mathematical proficiency and critical problem-solving capability. The level of significance was set at .05.

Ethical Consideration

The study observed voluntary participation, confidentiality, responsible data handling, and protection of learner information. The data were used for research and instructional planning purposes only and were reported in aggregate form. Since the respondents were basic education learners, the final submission should explicitly confirm documented parental or guardian consent, learner assent, and the institutional or division approval reference number when available.

RESULTS AND DISCUSSION

Academic Performance of KS3 Learners in Mathematics

Learners' preceding grade-level final grades in Mathematics showed that most respondents were classified under the Proficient and Approaching Proficiency categories. Out of 378 learners, 120 or 31.7% were Proficient and 114 or 30.2% were Approaching Proficiency. Meanwhile, 68 learners or 18.0% were Advanced, 57 or 15.1%

Table 2. Distribution of KS3 Learners According to Preceding Mathematics Grade

Grade description	Grade range	Grade 7	Grade 8	Grade 9	Grade 10	Total	Percentage
Advanced	90-100	19	18	14	17	68	18.0%
Proficient	85-89	34	32	25	29	120	31.7%
Approaching Proficiency	80-84	32	30	24	28	114	30.2%
Developing	75-79	16	15	12	14	57	15.1%
Beginning	Below 75	6	5	4	4	19	5.0%
Total		107	100	79	92	378	100.0%

The distribution indicates that many learners entered the current grade level with satisfactory mathematics achievement. However, the presence of learners in the Developing and Beginning categories shows that a significant group still requires remediation and targeted learning support. The relatively small proportion of Advanced learners also points to the need for enrichment activities that develop higher-order mathematical thinking.

Extent of Learners' Mathematical Proficiency

The learners demonstrated a high overall extent of mathematical proficiency, with an overall weighted mean of 3.39. Among the five strands, procedural fluency obtained the highest weighted mean of 3.56, interpreted as Very High. This indicates that learners were strongest in performing mathematical procedures accurately and efficiently. Productive disposition followed with a weighted mean of 3.47, while conceptual understanding obtained 3.42.

Table 3. *Extent of Learners' Mathematical Proficiency Across the Five Strands*

Mathematical proficiency strand	Weighted mean	Descriptive interpretation	Rank
Procedural fluency	3.56	Very High	1
Productive disposition	3.47	High	2
Conceptual understanding	3.42	High	3
Strategic competence	3.28	High	4
Adaptive reasoning	3.21	High	5
Overall mean	3.39	High	

Strategic competence obtained a weighted mean of 3.28, while adaptive reasoning obtained the lowest weighted mean of 3.21, although both were still interpreted as High. These results show that learners were more confident in applying procedures than in formulating strategies, explaining reasoning, or justifying mathematical solutions. This pattern supports the need for instructional practices that emphasize mathematical discourse, non-routine problem solving, and reasoning-based tasks.

Level of Critical Problem-Solving Capabilities

The learners demonstrated a high overall level of critical problem-solving capability, with an overall weighted mean of 3.35 and standard deviation of 0.55. Execution and analysis obtained the highest weighted mean of 3.53, interpreted as Very High. This shows that learners were strongest in applying operations, using procedures, and analyzing mathematical structures during solution processes.

Table 4. *Level of Learners' Critical Problem-Solving Capabilities*

Cognitive phase	Weighted mean	Standard deviation	Descriptive interpretation	Rank
Execution and analysis	3.53	0.49	Very High	1
Problem interpretation	3.41	0.52	High	2
Strategy formulation	3.28	0.56	High	3
Evaluation and reflection	3.17	0.61	High	4
Overall mean	3.35	0.55	High	

Problem interpretation obtained a weighted mean of 3.41, indicating that learners were generally able to identify given facts and determine the main problem. Strategy formulation obtained 3.28, showing that learners could plan solutions but may still need support in choosing efficient or creative strategies. Evaluation and reflection obtained the lowest mean of 3.17. This suggests that learners tended to focus on arriving at answers more than checking, justifying, or comparing solution methods.

Differences in Mathematical Proficiency by Grade Level and Preceding Mathematics Grade

One-way ANOVA results showed significant differences in mathematical proficiency when learners were grouped according to grade level and preceding Mathematics grade. For grade level, the F-value was 4.562 with a p-value of 0.004. For preceding Mathematics grade, the F-value was 8.725 with a p-value of less than 0.001. Since both p-values were below the .05 level of significance, the null hypotheses were rejected.

Table 5. *Differences in Learners' Mathematical Proficiency*

Grouping variable	F-value	p-value	Decision	Interpretation
Grade level	4.562	0.004	Reject Ho	Significant
Preceding Mathematics grade	8.725	0.000	Reject Ho	Significant

These findings suggest that learners' mathematical proficiency varied according to their developmental level and previous achievement in Mathematics. Learners with stronger preceding Mathematics grades tended to demonstrate higher proficiency. This highlights the importance of prior knowledge, foundational mastery, and continuous learning support across grade levels.

Differences in Critical Problem-Solving Capabilities by Grade Level and Preceding Mathematics Grade

The ANOVA results also revealed significant differences in critical problem-solving capabilities when learners were grouped by grade level and preceding Mathematics grade. For grade level, the F-value was 3.987 with a p-value of 0.008. For preceding Mathematics grade, the F-value was 9.841 with a p-value of less than 0.001. These results led to the rejection of the null hypotheses.

Table 6. *Differences in Learners' Critical Problem-Solving Capabilities*

Grouping variable	F-value	p-value	Decision	Interpretation
Grade level	3.987	0.008	Reject Ho	Significant
Preceding Mathematics grade	9.841	0.000	Reject Ho	Significant

The findings indicate that problem-solving capability develops differently across grade levels and is influenced by learners' prior mathematics achievement. Learners who previously attained higher Mathematics grades generally demonstrated stronger capacity in interpreting, planning, executing, and evaluating mathematical solutions. This supports the need for differentiated problem-solving instruction responsive to learners' achievement levels.

Summary of Inferential Findings

The inferential results show that both grade level and preceding Mathematics grade significantly influenced learners' mathematical proficiency and critical problem-solving capabilities. These findings emphasize the importance of using assessment results to inform instructional planning. Teachers may need to design tasks that match learners' current readiness while gradually increasing cognitive demand.

Table 7. *Summary of Significant Difference Findings*

Variable	p-value	Decision	Interpretation
Mathematical proficiency by grade level	0.004	Reject Ho	Significant
Mathematical proficiency by preceding Mathematics grade	0.000	Reject Ho	Significant
Critical problem-solving by grade level	0.008	Reject Ho	Significant
Critical problem-solving by preceding Mathematics grade	0.000	Reject Ho	Significant

Relationship Between Mathematical Proficiency and Critical Problem-Solving Capability

The study established a significant positive relationship between learners' mathematical proficiency and their critical problem-solving capabilities. This means that learners with higher levels of mathematical proficiency tended to demonstrate stronger ability to interpret, formulate, execute, analyze, evaluate, and reflect on mathematical solutions. The relationship confirms the theoretical connection between the five strands of mathematical proficiency and the cognitive phases of problem solving.

This finding has important instructional implications. Strengthening conceptual understanding can help learners interpret mathematical relationships, while procedural fluency supports accurate execution of operations. Strategic competence helps learners design solution approaches, adaptive reasoning helps them justify answers, and productive disposition encourages persistence when tasks become challenging. Therefore, interventions designed to improve problem solving should address all five strands of mathematical proficiency.

Proposed Mathematics Instructional Intervention Matrix

Based on the findings, the following instructional intervention matrix is proposed to strengthen learners' mathematical proficiency and critical problem-solving capabilities. The matrix prioritizes the lower-rated areas of adaptive reasoning, strategic competence, and evaluation and reflection while sustaining strengths in procedural fluency and execution.

Table 8. *Proposed Mathematics Instructional Intervention Matrix*

Priority area	Basis from findings	Suggested instructional response	Expected outcome
Adaptive reasoning	Lowest mathematical proficiency strand, WM = 3.21	Use justification tasks, error analysis, mathematical arguments, and explanation prompts.	Learners improve logical reasoning and defense of solutions.
Strategic competence	Lower proficiency strand, WM = 3.28	Use non-routine problems, multiple-solution tasks, mathematical modeling, and representation activities.	Learners strengthen planning and strategy selection.
Evaluation and reflection	Lowest problem-solving phase, WM = 3.17	Require checking of answers, alternative methods, reflective journals, and solution comparison.	Learners develop metacognitive problem-solving habits.
Differentiated instruction	Significant differences by grade level and preceding Mathematics grade	Group learners by readiness, provide tiered tasks, and use formative assessment for regrouping.	Instruction responds to diverse learner needs.
Teacher professional development	Need to strengthen reasoning and problem-solving instruction	Conduct LAC sessions on problem-based learning, mathematical discourse, and assessment design.	Teachers design stronger mathematics learning experiences.

CONCLUSION

The study concludes that Key Stage 3 learners of SDO Iriga City generally demonstrated satisfactory academic performance in Mathematics, with most learners classified under Proficient and Approaching Proficiency levels. Learners also exhibited a high overall extent of mathematical proficiency across conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. Procedural fluency emerged as the strongest strand, while adaptive reasoning was the weakest, indicating that learners were more confident in carrying out procedures than in explaining and justifying mathematical ideas.

Learners also demonstrated a high overall level of critical problem-solving capability. Execution and analysis was the strongest cognitive phase, while evaluation and reflection was the weakest. This suggests that learners were relatively capable of performing operations and arriving at solutions but needed more support in checking answers, justifying results, and considering alternative approaches.

Significant differences were found in mathematical proficiency and critical problem-solving capabilities when learners were grouped according to grade level and preceding Mathematics grade. These results show that developmental level and prior achievement influence learners' mathematical readiness and problem-solving performance. A significant positive relationship was also established between mathematical proficiency and critical problem-solving capability, confirming that stronger mathematical proficiency is associated with stronger problem-solving skills. The findings therefore support the development of targeted, differentiated, and reasoning-centered mathematics interventions for KS3 learners.

Recommendation

Mathematics teachers should strengthen differentiated instruction based on learners' grade level, prior achievement, and current proficiency profile. Lessons should include tiered activities, formative assessments, and targeted remediation for learners in the Developing and Beginning categories. Advanced and Proficient learners should be provided with enrichment tasks that involve non-routine problems, mathematical modeling, and higher-order reasoning.

Schools should implement targeted intervention programs that focus on adaptive reasoning, strategic competence, and evaluation and reflection. Teachers may use problem-based learning, open-ended questions, mathematical discourse, error analysis, reflective journals, and solution-justification tasks to develop deeper reasoning. These interventions should be aligned with the K to 12 Mathematics Curriculum and contextualized to the needs of Irigueño learners.

School heads, mathematics coordinators, and curriculum planners should use the study findings as basis for Learning Action Cell sessions and professional development on problem-solving-oriented instruction. Teachers should be trained in designing assessments that measure not only computation but also interpretation, strategy formulation, reasoning, and reflection. Future researchers may conduct longitudinal, experimental, or mixed-method studies to evaluate the effectiveness of proposed interventions and explore other factors that influence mathematical proficiency and critical problem-solving performance.

References

Ariyanti, G., & Santoso, F. G. I. (2020). Analysis of mathematics learning outcomes based on students' critical thinking skills. Journal of Physics: Conference Series, 1464, Article 012014.

Department of Education. (2016). K to 12 curriculum guide: Mathematics. Department of Education.

Department of Education. (2019). PISA 2018 national report of the Philippines. Department of Education.

Department of Education. (2022). National Achievement Test results and mathematics performance report. Department of Education.

Ho, T. M. P. (2020). Measuring conceptual understanding, procedural fluency and integrating procedural and conceptual knowledge in mathematical problem solving. International Journal of Scientific Research and Management, 8(5), 1334-1350. https://doi.org/10.18535/ijsrm/v8i05.el02

Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). Adding it up: Helping children learn mathematics. National Academy Press.

Meilani, A., & Meiliasari. (n.d.). Systematic literature review: Kemampuan pemecahan masalah matematis peserta didik dalam pembelajaran matematika. https://doi.org/10.37150/ftdz9c29

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics. National Council of Teachers of Mathematics.

Organisation for Economic Co-operation and Development. (n.d.). Student problem solving skills. OECD. https://www.oecd.org/en/topics/problem-solving.html

Organisation for Economic Co-operation and Development. (2019). PISA 2018 results: What students know and can do (Vol. I). OECD Publishing.

Polya, G. (1945). How to solve it: A new aspect of mathematical method. Princeton University Press.

Schoenfeld, A. H. (1985). Mathematical problem solving. Academic Press.

Suryawan, I. P. P., Sudiarta, I. G. P., & Suharta, I. G. P. (2023). Students' critical thinking skills in solving mathematical problems: Systematic literature review. Indonesian Journal of Educational Research and Review, 6(1), 120-133. https://doi.org/10.23887/ijerr.v6i1.56462

Yulian, V., & Wahyudin. (2018). Analysing categories of mathematical proficiency based on Kilpatrick opinion in junior high school. Journal of Physics: Conference Series, 1132(1), Article 012052. https://doi.org/10.1088/1742-6596/1132/1/012052

Methodologies to reveal young Australian Indigenous students' mathematical proficiency. (2023)., 36, 311-338.