

# Collaborative Problem Posing As A Pathway To Enhance Higher-Order Thinking Skills Among Grade 7 Students

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**Abstract-** *Developing higher-order thinking skills (analysis, evaluation, and creation) is essential in helping students go beyond procedural understanding toward meaningful engagement with mathematical concepts. Despite the emphasis in curricula on critical and creative thinking, traditional mathematics instruction often limits students to solving routine problems, offering few opportunities for deeper reasoning and exploration. This research addresses the need for innovative strategies that actively engage learners in constructing mathematical knowledge, with a focus on collaborative problem-posing. The study employed a pre-experimental design using a one-group pretest-posttest method to measure how collaborative problem-posing enhances students' higher-order thinking Skills. The participants were Grade 7 students from a public secondary school who were taught about integers over a period of three weeks. Before the intervention, students were given a teacher-made pretest that assessed various levels of Higher-Order Thinking Skills (HOTS), aligned with Bloom's Taxonomy, focusing on their ability to analyze, evaluate, and create. The results revealed a significant increase in post-test scores compared to the pretest scores. The p-value in the three higher-order thinking skills (analyzing, evaluating, and creating) confirms that the improvement was not due to chance but rather the effectiveness of the collaborative problem-posing activities.*

**Keywords-** Collaborative Approach, Collaborative Problem Posing, Higher Order Thinking Skills, Teaching Mathematics

## I. INTRODUCTION

Teaching Mathematics in junior high schools in the Philippines remains a complex challenge due to students' perception of it as an abstract and difficult subject with limited visible application in daily life (Purnami et al., 2018). To counter this, scholars such as Sinay (2016) and Khan (2015) emphasize the importance of linking mathematical concepts to real-world situations and fostering essential thinking skills, including reasoning, problem-solving, and critical reflection. In the Philippines, the MATATAG Curriculum (2023)

supports this by promoting mathematical proficiency, which encompasses both competence and confidence in applying concepts to solve problems in varied contexts.

Aligned with the Department of Education's goal to develop globally competitive learners, DepEd initiatives such as the Basic Education Research Agenda (BERA) and the Philippine Professional Standards for Teachers (PPST) encourage the integration of higher-order thinking skills (HOTS) into teaching practices. These include analyzing, evaluating, and creating, which are the key stages in the revised Bloom's Taxonomy. Research highlights the need for diverse teaching strategies to address the different needs of learners and promote a deeper understanding (Cardino Jr. et al., 2020; Meador, 2018), advocating for a shift from traditional methods to more active and engaging approaches.

One emerging strategy is collaborative learning, particularly collaborative problem posing, which allows students to co-construct knowledge by formulating or reformulating problems together (Schindler & Bakker, 2020). This method fosters interaction, critical thinking, and deeper learning (Abubakar & Arshad, 2015; Daud et al., 2019). Collaborative problem-posing not only encourages engagement but also builds students' confidence, creativity, and ability to tackle mathematical challenges, making it a powerful approach for enhancing higher-order thinking skills in the classroom. This research aims to explore further its impact in the Philippine junior high school context.

The 2022 PISA results revealed that the Philippines ranked lowest among ASEAN countries in mathematics, scoring 355 compared to the OECD average of 472, with only 16% of students achieving Level 2 proficiency and none reaching Levels 5 or 6. These results suggest that most Filipino students possess only basic mathematical skills and struggle to apply mathematical reasoning to real-life contexts. This underperformance aligns with results from other assessments, such as TIMSS 2019 and local school evaluations, including the MPS of Sta. Catalina Integrated National High School, which showed that Grade 7 students

scored only 62.24%, with poor performance on higher-order thinking skill (HOTS) questions. These findings highlight a significant gap in students' ability to solve complex and non-routine problems requiring deeper cognitive engagement.

In response, the Department of Education (DepEd) promotes innovative teaching strategies that strengthen students' critical and problem-solving skills, with an emphasis on developing higher-order thinking. Among these strategies, collaborative problem-posing has shown promising results in improving students' critical, creative, and mathematical thinking. Researchers argue that this approach fosters active participation, enhances students' confidence, and enables them to build on prior knowledge through peer interaction and group analysis. It fosters inclusivity and equity by creating engaging classroom environments where students work collaboratively to formulate and solve problems. As such, collaborative problem-posing is a strategic method for addressing the cognitive skill gaps reflected in both international and local assessments.

## II. LITERATURE REVIEW

Collaborative learning is an instructional approach where students work together to achieve shared academic goals through active interaction, negotiation, and mutual responsibility for learning. Warsah et al. (2021) emphasized that this strategy encourages learners to utilize both cognitive and metacognitive skills in problem-solving. It is not merely about cooperation or division of labor but rather about the construction of shared understanding and knowledge through meaningful collaboration, as supported by Hadwin et al. (2015) and Roselli (2016). This approach fosters individual accountability while promoting interdependence within a group, making learning more socially grounded and intellectually enriching.

The effectiveness of collaborative learning depends heavily on the quality of social interactions and effective teacher facilitation. According to Curseu et al. (2017), collaboration reduces the cognitive load on individuals and enhances both academic and teamwork skills through collective engagement. However, this can only be fully realized with proper guidance and well-structured tasks, as noted by De Hei et al. (2015). In such settings, each learner contributes their strengths and supports others, creating an environment that fosters not only academic proficiency but also essential life skills, such as communication, critical thinking, and cooperation (Fideli & Aliazas, 2022).

Researchers also emphasize that collaborative learning fosters cross-domain competencies, including

argumentation, reasoning, and perspective-taking. Techniques such as "think-pair-share" (Abalde and Oco, 2023) and socio-cognitive activities, including questioning and debating (Vogel et al., 2017), are shown to develop both content knowledge and broader cognitive abilities. While collaborative learning holds great promise, studies also point out that students often struggle to engage effectively without structured support. Therefore, successful implementation relies on well-designed tasks, active teacher facilitation, and fostering a classroom culture that values shared inquiry and meaningful interaction.

Problem posing in mathematics is a multifaceted process that involves generating or reformulating problems based on real or imagined contexts. Malaspina et al. (2016) identify four critical elements —information, requirement, context, and mathematical environment—that can be manipulated to create new problems. Context may be abstract or real-world, and the goal is to foster mathematical creativity and deeper conceptual understanding. Lee et al. (2018) and Singer et al. (2015) argue that problem-posing enhances mathematical performance, promotes the transfer of knowledge, and is integral to both teaching and scientific inquiry. It is viewed as a powerful educational tool that fosters flexibility, fluency, and originality, especially when students are encouraged to engage in open-ended or semi-structured problem-solving tasks.

Several classifications of problem posing exist, including generating new problems, reformulating existing ones, combining both approaches, asking new questions, and using real-life modeling. Studies by Papadopoulos et al. (2022) and Cai et al. (2020) highlight that these approaches enable students to apply prior knowledge, analyze scenarios, and develop both problem-solving and critical thinking skills. Structurally, problem-posing tasks may be free (unstructured), semi-structured, or structured, each offering varying degrees of guidance and complexity (Presnillo & Aliazas, 2024). Arikan and Unal (2014) noted that engaging students in problem posing could reduce math anxiety, increase confidence, and stimulate creative thought by shifting the focus from finding correct answers to generating meaningful problems.

The collaborative aspect of problem posing has gained recognition for its effectiveness in improving student learning outcomes. Research by Christidamayani and Kristanto (2020) and Cai and Leikin (2020) supports the use of group-based problem-posing to enhance social interaction, active participation, and shared cognitive effort. Students who engage in collaborative problem-posing exhibit greater involvement, understanding, and responsibility throughout the learning process. This approach not only reinforces content

knowledge but also fosters communication, critical analysis, and teamwork, making it a powerful pedagogical strategy in modern mathematics classrooms.

Hilmi et al. (2022) emphasized that mathematics education must address students' cognitive development, distinguishing between lower-order and higher-order thinking skills (HOTS) based on Anderson and Krathwohl's revised Bloom's taxonomy. Lower-order thinking skills involve remembering, understanding, and applying routine procedures. In contrast, Higher-Order Thinking Skills (HOTS) involve analyzing, evaluating, and creating—skills that challenge students to think critically and solve non-algorithmic problems. They emphasized that mastery of lower-order skills is foundational for the development of Higher-Order Thinking Skills (HOTS), highlighting a hierarchical structure in cognitive development where both levels must be nurtured for effective learning.

Several scholars emphasize the importance of HOTS in achieving educational success. Retnawati et al. (2018) and Tanujaya et al. (2017) noted that students with well-developed HOTS show better academic outcomes due to improved reasoning and problem-solving abilities. Apriyanti et al. (2014) equated HOTS with critical thinking in the upper levels of Bloom's taxonomy and outlined skills such as comparison, patterning, and deductive reasoning as essential components. These thinking processes are crucial when students face novel challenges, requiring them to apply prior knowledge in new and diverse contexts. The development of HOTS fosters students' capacity for deep understanding, reflective thought, and innovative problem-solving.

Furthermore, scholars like Samo (2017) and Febrina et al. (2019) provided detailed characterizations of analyzing, evaluating, and creating as essential HOTS components, linking them to metacognitive and problem-solving abilities. Delima (2017) also associated HOTS with non-algorithmic tasks that demand critical judgments, new idea generation, and analytical reasoning, particularly in mathematical contexts. These scholars argue that crafting high-quality, cognitively demanding questions promotes higher-order learning. In this way, HOTS not only supports academic achievement but also cultivates students' ability to think independently, solve complex problems, and transfer learning to unfamiliar situations.

### III. METHODOLOGIES AND RESULTS

This study employed a pre-experimental one-group pretest-posttest design, in which a single group of participants took a pretest, underwent an intervention, and then completed

a post-test to measure the changes. This design assesses the impact of a treatment by comparing outcomes before and after the intervention within the same non-random group. The focus of the research was to evaluate the development of higher-order thinking skills through Collaborative Problem Posing, with statistical analysis conducted on the pretest and post-test scores to determine any significant differences.

The study involved 38 Grade 7 students from Sta. Catalina Integrated National High School during the 2024–2025 school year. These students were selected using cluster sampling, where entire sections served as natural clusters. As defined by Simkus (2022), cluster sampling involves dividing a population into groups and randomly selecting one or more groups from among them. The students' heterogeneity in backgrounds, abilities, and learning styles enriched the data, providing valuable insights into how collaborative problem-posing influenced their higher-order thinking skills. Cluster sampling was deemed appropriate given the existing class groupings.

The researcher began by administering a pretest to assess the students' higher-order thinking proficiency levels before introducing the collaborative problem-posing approach. Collaborative problem-posing was then integrated into the teaching and learning process over a period of three weeks. During the establishing and developing phases, students were given investigatory or case study problems to solve in groups. After solving the initial problems, students created similar problems by modifying the given conditions and providing corresponding solutions. These student-generated problems were then exchanged with other groups for solving, promoting peer engagement and deeper understanding.

Throughout the lesson, students were engaged in various phases of problem-posing. During lesson activities, they created problems based on equations, tables, pictures, or other mathematical representations, providing solutions aligned with the ongoing topic. In the evaluation phase, each group independently created and solved its own problems without guidance or data provided by the teacher. These problems were assessed using a rubric to evaluate the depth and quality of higher-order thinking involved. After three weeks of this instructional approach, a post-test was administered, and the researcher compared the results with the pretest to determine any significant improvement in the students' higher-order thinking proficiency.

The results of the pretest and post-test are presented below in terms of the higher-order thinking skills:

**Table 1. Pretest and Post-test Results in terms of Analyzing Level**

Analyzing Level	Pretest		Post-test	
	f	%	f	%
Advanced	-	-	19	50
Proficient	-	-	11	28.95
Approaching Proficient	-	-	5	13.6
Developing	29	76.32	3	7.89
Beginning	9	23.68	-	-
	38	100.0	38	100.0

The pretest results revealed that the majority of the Grade 7 students were at the developing proficiency level in terms of analyzing. None of the students reached the approaching proficient, proficient, or advanced levels. This suggests that most students had only minimal knowledge and understanding of analyzing tasks and required significant support to perform authentic mathematical tasks. At this stage, students struggled to distinguish between new and familiar mathematical concepts. Their problem-solving approaches often relied on surface-level understanding or rote procedures, which were not suitable for tasks that required deeper analysis, such as distinguishing relevant from irrelevant information or selecting appropriate strategies based on the problem's structure.

After the implementation of collaborative problem-posing, the post-test results showed significant improvement, with half of the respondents reaching the advanced Level. According to the Department of Education (2023), students at this Level demonstrate mastery of knowledge and skills and can apply them flexibly in new contexts. These students demonstrated a strong ability to deconstruct complex problems, identify essential information, and select effective problem-solving strategies. Logical reasoning, precise calculations, and insightful evaluation of the various components of the problem characterized their solutions. This shift in performance indicates a marked development in the student's analytical thinking and problem-solving capabilities.

Collaborative problem-posing was a key factor in improving the students' proficiency. By working in groups to create and solve their problems, students actively engaged with mathematical concepts. They were required to think critically about the structure, logic, and purpose of the problems. This process helped them internalize key analyzing skills—such as identifying relationships among integers, organizing information meaningfully, and distinguishing necessary details. Furthermore, the collaborative aspect of the task fostered discussion, reasoning, and peer feedback, all of

which reinforced their analytical skills. As a result, students not only improved their ability to analyze given problems but also demonstrated the capacity to independently construct and solve complex mathematical tasks, illustrating the effectiveness of the collaborative problem-posing approach.

**Table 2. Pretest and Post-test Result in terms of Evaluating Level**

Evaluating Level	Pretest		Post-test	
	f	%	f	%
Advanced	-	-	10	26.32
Proficient	-	-	21	55.26
Approaching Proficient	3	7.89	5	13.16
Developing	12	31.58	2	5.26
Beginning	23	60.53	-	-
	38	100.0	38	100.00

The pretest results revealed that the majority of Grade 7 students were at the beginning proficiency level in terms of evaluating, with none reaching the proficient or advanced levels. This indicates that most students lacked the foundational knowledge and critical thinking skills necessary for evaluative tasks, such as assessing solutions or justifying the appropriateness of strategies. At this stage of evaluating, students are expected to go beyond understanding and applying, where they must judge the validity of a method and reflect on the logic of their solutions. However, many students demonstrated only a superficial approach to problem-solving, failing to question whether their operations or procedures were suitable for the given problems.

Following the implementation of collaborative problem posing, there was a significant improvement in student performance, as evidenced by the post-test results. Most students moved to the proficient Level, indicating a deeper understanding of integer operations and the ability to apply their knowledge independently in both routine and some non-routine problems. Unlike their earlier performance, these students began to demonstrate skills aligned with the evaluating cognitive Level. They could now reflect on their problem-solving process, assess which strategies were most effective, and provide explanations that supported their answers. This growth shows that students not only improved in solving mathematical problems but also in evaluating the quality of their solutions and reasoning more critically.

Collaborative problem-posing played a key role in this advancement. By engaging students in activities where they constructed and critiqued problems with their peers, the process required them to analyze relationships among

mathematical concepts, question assumptions, and reflect on the validity of their solutions. Peer interaction provided opportunities for dialogue, allowing students to compare strategies and refine their reasoning. These tasks developed the students' ability to justify their solutions and critique both their work and that of others. Consequently, students became more reflective and confident in their decision-making, demonstrating emerging mastery of evaluation skills. This growth in evaluative thinking highlights the effectiveness of collaborative problem-solving in enhancing higher-order cognitive abilities.

**Table 3. Pretest and Post-test Results in terms of Creating Level**

Creating Level	Pretest		Post-test	
	f	%	f	%
Advanced	-	-	10	26.32
Proficient	-	-	8	21.05
Approaching Proficient	-	-	6	15.79
Developing	1	2.63	12	31.58
Beginning	37	97.37	2	5.26
	38	100.0	38	100.00

The pretest results revealed that nearly all Grade 7 students were at the beginning proficiency level when assessed on the creating component of higher-order thinking. None of the students reached advanced, proficient, or even approaching proficient levels. This indicates a significant struggle in applying integer concepts to tasks that require designing plans or creating movement-based scenarios. Students at this Level lacked the conceptual depth, flexibility, and confidence needed to construct meaningful mathematical solutions. Additionally, the cognitive demands of earlier tasks, such as analyzing and evaluating, consumed a significant portion of their mental energy and time, leaving them underprepared and constrained when they reached the creating-level tasks.

In contrast, the post-test results showed notable improvement in student performance, with most students advancing to the developing Level and 26.32% reaching the advanced Level. This shift highlights the effectiveness of collaborative problem-solving in enhancing students' ability to synthesize and apply knowledge creatively. The collaborative environment encouraged students to engage more deeply with mathematical concepts, as they were tasked with generating their problems and designing solutions. This active involvement fostered a deeper understanding of integer

operations and enabled students to apply their learning to novel, real-world scenarios. By developing their problems, students were able to think more flexibly and imaginatively, key characteristics of proficiency in the creating domain.

The integration of collaborative problem-solving played a pivotal role in this growth. Students were not only solving problems but also constructing them—an exercise that demands higher-level thinking, planning, and innovation. They were required to create realistic scenarios using integers, such as simulating changes in elevation or financial transactions, and justify their problem structure and solutions. This process of generating and refining mathematical tasks encouraged critical dialogue, peer collaboration, and reflection. It provided a supportive platform for students to build confidence in their creative problem-solving abilities. As a result, students became more adept at formulating original ideas and applying integer concepts meaningfully, leading to a measurable advancement in their proficiency level.

**Table 4. Test of Significance**

Higher Order Thinking Skills	Mean	t	Sig.	Verbal Description
Analyzing	5.55 18.32	-19.926	0.000	Significant
Evaluating	3.92 16.97	-20.050	0.000	Significant
Creating	0.58 13.37	-11.988	0.000	Significant

The statistical results reveal a significant difference between the students' pretest and post-test scores across all higher-order thinking skills — analyzing, evaluating, and creating — with p-values of 0.000 for each. Since these values are below the 0.05 significance level, this indicates a statistically significant improvement in students' performance after the intervention. This implies that the implementation of collaborative problem-posing had a substantial positive impact on enhancing students' higher-order cognitive skills. It supports the idea that structured collaborative tasks can deepen students' engagement with complex mathematical thinking.

This improvement suggests that collaborative problem-posing fosters a deeper understanding of mathematical concepts by requiring students to analyze relationships, evaluate strategies, and construct original problems. Students learned to identify relevant information, break down mathematical structures, and comprehend how different operations interact, particularly with integers.

Research by Özdemir and Şahali (2018) and Cai et al. (2015) supports the notion that problem-posing not only enhances academic achievement but also fosters the development of critical thinking and conceptual understanding. Through peer interaction and reflection, students became more adept at recognizing mathematical patterns and applying them to real-world and abstract problems.

Furthermore, collaborative problem-posing strengthened the students' ability to evaluate and create mathematical problems. It required them to assess the validity of operations, justify their reasoning, and model real-life situations involving integers, such as temperature changes or financial scenarios. As students constructed and critiqued problems collaboratively, they developed creative thinking and the ability to transfer mathematical knowledge to new contexts. Studies by Sangco et al. (2022) and Wessman-Enzinger and Tobias (2022) emphasize that this approach supports divergent thinking and creativity in mathematics. Importantly, students' advancement to the creating Level was built upon their progress in analyzing and evaluating—demonstrating that higher-order thinking skills are interdependent and effectively nurtured through collaborative problem-posing.

#### IV. CONCLUSION

The study's results demonstrate a significant improvement in students' higher-order thinking skills, including analysis, evaluation, and creation, following the implementation of collaborative problem-posing. The statistical findings, with p-values of 0.000 across all three cognitive domains, confirm the effectiveness of this strategy. Initially, most Grade 7 students exhibited low proficiency levels, particularly in analyzing and creating, where none reached even the approaching proficient category. This highlighted the students' reliance on surface-level strategies and a lack of deeper conceptual understanding. However, after collaborative problem-posing was introduced, there was a notable increase in the number of students reaching proficient and advanced levels, underscoring the strategy's impact on developing critical and creative thinking skills.

The improvement in student performance suggests that collaborative problem-posing creates a rich learning environment where students can engage actively with mathematical concepts. By encouraging students to construct and solve problems in groups, this approach fosters analytical thinking, strategic decision-making, and self-reflection. Students learned to identify key information, evaluate the appropriateness of mathematical methods, and explore the interconnectedness of operations—particularly with integers.

As seen in their post-test scores, students progressed from rote procedures to logical reasoning and independent problem-solving. The interactive and reflective nature of collaborative tasks contributed to deeper comprehension and better retention of mathematical ideas.

In addition, the ability of students to reach the creating Level demonstrated how collaborative problem-posing nurtures divergent thinking and the application of knowledge in novel contexts. Students began constructing original problems, simulating real-life scenarios, and offering justified solutions. These activities not only enhanced their creativity but also improved their confidence and autonomy in problem-solving. Importantly, this growth in creating skills was built upon prior development in analyzing and evaluating, affirming the interrelated nature of higher-order thinking skills. Overall, the findings confirm that collaborative problem-posing is a powerful pedagogical tool for fostering comprehensive mathematical understanding and cognitive growth among learners.

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