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Enhancing Students' Performance in Solving Problems Involving Signed Numbers through Bingo Number Tower Game (NTG)

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ABSTRACT

This study investigated the effectiveness of the Bingo Number Tower Game (NTG) in addressing signed numbers as a least learned competency among first-year Bachelor of Elementary Education (BEED) students in Mathematics in the Modern World (MMW). Using a quasi-experimental pretest-posttest design with control and experimental groups, the research assessed whether game-based intervention could improve student performance compared to traditional instruction. Initial assessments confirmed significant learning gaps in signed number proficiency across both groups. Following the intervention, the experimental group demonstrated substantially greater improvement in problem-solving performance than the control group. Statistical analyses confirmed the NTG's effectiveness, revealing significant differences in post-intervention outcomes between the two instructional approaches, with the experimental group exhibiting a very large and consistent positive effect on learning gains. The findings suggest that game-based learning strategies such as the NTG can effectively remediate foundational mathematical competencies, providing a promising alternative to conventional teaching methods in MMW and teacher education programs. The study contributes to the growing body of research supporting innovative pedagogical approaches in mathematics education.

Keywords: signed numbers, least learned competency, game-based learning, Bingo Number Tower Game, Mathematics in the Modern World, problem-solving

INTRODUCTION

The foundations of life rely on mathematics because the discipline aids both problem-solving capabilities and decision-making tasks and critical thinking processes. It functions as a critical instrument throughout natural science along with engineering branches as well as medicine and finance and social sciences (Tella, 2021). Through its real-world mathematics exposition, he Mathematics in Modern World (MMW) course develops essential abilities for logical reasoning together with problem-solving for students. The students participating in MMW courses face significant difficulties understanding basic concepts including signed numbers. The collection of positive numbers together with negative numbers represents signed numbers. Integers are what these mathematical quantities represent rather than natural numbers or positive integers. The concept of signed numbers applies to all rational numbers while excluding only the negative ones. The research group focuses on real numbers which extends beyond non-negative real numbers according to Peled (2006). The combination of mathematical difficulties with basic operations and PEMDAS/BODMAS rules and word problem solving causes students to perform poorly in school work along with decreasing their perception of their own abilities. Standard teaching methods show weakness in student engagement and handling different learning methods so innovative approaches like gamification become necessary.

Research from both Philippines and international fields create evidence of these difficulties. Dela Cruz (2021) together with Reyes et al. (2022) conducted research which demonstrates that students regularly fail to perform well in tasks requiring signed numbers therefore affecting their ability to handle advanced mathematical problems. A similar pattern exists in physics education according to Reddy and Panacharoensawad (2017) because students experience problems solving kinematic problems because they combine faulty formula application with weak algebraic reasoning skills. All research points to a repeating discovery that students' early struggles with procedures in math concepts (such as signed numbers) create wider learning obstacles. Misconceptions- such as ignoring negative signs or believing subtraction cannot yield negative results—further compound these difficulties. Internationally, game-based learning has shown promise in addressing these challenges. A study by Bofferding and Hoffman (2019) demonstrate that games can make abstract concepts like negative numbers more accessible and engaging, improving students' understanding and retention. Recent research further supports this, with Kailani, Newton, and Pedersen (2019) highlighting game-based learning as a powerful context for nurturing problem-solving skills, while Plass, Homer, and Kinzer (2015) emphasize that engaging storylines and appealing tasks in game-based environments enhance students' engagement and perceived achievement.

This study investigates the effectiveness of the Bingo Number Tower Game (NTG), a game-based intervention designed to teach signed numbers through a dynamic, competitive format. The game encourages students to solve problems involving signed numbers, fostering teamwork, critical thinking, and problem-solving skills in a low-pressure, engaging environment. The study focuses on first-year Bachelor of Elementary Education (BEED) students, assessing whether NTG improves their performance in solving signed number problems by comparing pre-test and post-test scores.

This study is anchored in Constructivism (Piaget & Vygotsky), which posits that learners actively construct knowledge through social interaction, a principle embodied in NTG's collaborative problem-solving environment; Flow Theory (Csikszentmihalyi), which emphasizes the importance of immersive, skill-balanced challenges that NTG implements to sustain engagement; Experiential Learning Theory (Kolb), where learning emerges through reflective practice, a process NTG facilitates through iterative problem-solving cycles; Self-Determination Theory (Deci & Ryan), which identifies autonomy, competence, and relatedness as key motivators, all nurtured in NTG through student-driven tasks and peer collaboration; and Cognitive Load Theory (Sweller), which advocates for structured information presentation, a feature of NTG's interactive problem design. The current mathematics teaching methods ignore basic principles from important educational theories that cause students to lose interest and develop weak problem-solving abilities. The research investigates NTG's theoretical foundation which boosts mathematical problem-solving competencies and learning initiative and educational achievement by linking three related educational models. The problems lead students to get weak academic results and reduce their faith in solving mathematical problems. The study presents the Bingo Number Tower Game (NTG) as its main game-based intervention to help students perform better. The study aims to measure the participants' existing ability in signed number problems when working with basic operations and order of operations and word problems. It measures if NTG produces important progress

This research uses the Input-Process-Output (IPO) conceptual framework to analyze the NTG intervention as input which leads to improved problem-solving performance of first-year BEED students solving signed number problems as the output. The study integrates game-based methods to improve student math abilities and confidence together with assessment of optimal educational techniques for basic mathematics instruction.

Empirical research combined with theoretical foundations will help establish whether NTG generates effective improvements in students' signed number operation ability as a potential solution to ongoing mathematics education problems.

2. METHODOLOGY

2.1. Research Design

This is a quasi-experimental research which used a two- group pretest - post test design. The level of knowledge of the participants on Signed Numbers, a least learned competency in the course Mathematics in the Modern World was measured before the intervention was implemented and after it is implemented.

The two-group pretest - post test design has three essential components: it is quasi-experimental in nature because the participants in the experimental (with intervention) and control (did not undergo intervention) group will be randomly selected; there is a control group to compare the results with; pre- and post-intervention measurements are compared to determine the effectiveness of the intervention. The null hypothesis is that there is no difference in which two measurements are equivalent from the control and experimental group.

2.2. Respondents of the Study

The study utilized purposive sampling, a non-random sampling technique, to select respondents. All first-year students enrolled in the Mathematics in the Modern World course during the second semester at the School of Teacher Education were eligible to participate as respondents. This sampling approach ensured that respondents had relevant exposure to foundational mathematical concepts while maintaining the study's focus on signed number proficiency development. The respondents are 17 first-year college students from the School of Teacher Education, Bachelor of Elementary Education program at Biliran Province State University. They are considered appropriate respondents because they are the only program currently enrolled in the Mathematics in the Modern World course during the second semester in the School of Teacher Education.

Improving BEED students' proficiency in signed numbers will help ensure that they are well-equipped to teach mathematical concepts to their future students in an accessible and effective way. The study aligns with the pedagogical goals of the teacher education program, promoting both subject matter knowledge and teaching strategies that can be passed down to the next generation of learners.

2.3. Research Instrument

The primary tool used in this study was 14 items researchers' made test questionnaire originally created from a self-learning material in the Mathematics in the Modern World module. Two types of assessments were administered: a Pre-test and a Post-test. Both tests contained the same set of questions in the same order to maintain consistency in measuring student learning progress. To ensure the validity and reliability of the instrument, the questionnaire underwent expert validation and an internal consistency reliability test. Four mathematics experts assessed the instrument for content relevance and clarity.

Based on their evaluations, minor revisions were incorporated to enhance its precision and alignment with the study's objectives. Additionally, the content validation analysis indicated that one item is needed to be deleted due to issues with clarity and relevance, resulting in a revised 14-item test. The content validation analysis confirmed the appropriateness of the questionnaire for measuring student learning outcomes. The I-CVI checks individual item validity: if it's above 0.79, the item is great; between 0.70–0.79, it's okay but may need tweaks; and below 0.70, it should be removed. The S-CVI looks at the scale as a whole: if the S-CVI/Ave is 0.90 or higher, or the S-CVI/UA is 0.80 or higher, the scale has excellent validity. These indexes help ensure the items and the scale truly measure what they're meant to.

Following expert or face validation, the gathered raw data underwent an internal consistency reliability test, yielding a Cronbach's Alpha of 84.2. This result, interpreted as good, indicates that the test questionnaire possesses a reasonable degree of reliability. Internal consistency reliability measures how well the items in a test or scale assess the same underlying construct, with Cronbach's alpha serving as a common method for assessing this reliability.

Furthermore, the researchers created a comprehensive 4A's Detailed Lesson Plan to facilitate the execution of the Bingo Number Tower Game. This instructional plan was specifically designed to address the least-learned competency among first-year BEED students, ensuring a structured and effective intervention.

2.4. Data Gathering Procedure

Before beginning the study, the researchers submitted a formal request letter endorsed by the dean of BiPSU's School of Teacher Education. They also obtained approval from the instructor of the Mathematics in the Modern World course to involve the selected first-year Bachelor of Elementary Education (BEED) students.

Once authorized, the researchers conducted a 14-item pre-test with the first-year BEED students, allowing 40 minutes to complete it. The test assessed their ability to solve problems involving signed numbers. After the pre-test, the researchers introduced the intervention—the Bingo Number Tower Game (NTG)—using a 4A's Semi-Detailed Lesson Plan that incorporated the game. The entire intervention was completed for two weeks every Tuesday and Friday. Finally, a 14-item post-test was administered to evaluate the learning improvement of the experimental group compared to the control group.

Bingo Number Tower Game (NTG)

This intervention was based on the study of Conte (2019). The game was inspired by Bingo, as questions were drawn randomly, similar to how numbers are called in a Bingo game. The experimental group received 55 Bingo tiles, each representing possible answers to the math problems. A total of 110 questions were provided, ensuring multiple instances of the same answer so that all tiles could potentially be used.

The procedure for Bingo Number Tower Game (NTG)

1. After the abstraction phase in the 4A's lesson plan, the researchers moved to the application phase by implementing the Bingo Number Tower Game. The class of 17 students was divided into two groups: 9 in the control group and 9 in the experimental group. The control group completed a seatwork with 110 questions, while the experimental group answered the same set of questions using the NTG intervention. The groups were positioned on opposite sides of the classroom to allow space for the experimental group to build their number towers.
2. The game began by shuffling 55 answer tiles into a pile. Using 110 questions, the game master call out each question, similar to bingo. Players should solve the problems using available tools (except calculators) within a set time limit after the game master read the question. Speed and accuracy were essential as time is limited.
3. After solving a problem, players should match their answer with the correct answer tile and placed it on their tower, stacking the tiles vertically.
4. If their answer is correct, the players are allowed to keep the tile in the tower and move to the next problem. Incorrect answers required the player to retrieve the tile to the pile and try again. Players were encouraged to ensure the stability of their tower, even when correcting mistakes.
5. As the game progress, players continue building their towers with a specific structure: a 5x5 base (25 tiles), a 4x4 second layer (16 tiles), a 3x3 third layer (9 tiles), a 2x2 fourth layer (4 tiles), and a final 1-tile top layer. This structure help maintain the tower's stability while using all 55 tiles.
6. Players should aim to solve the 110 problems within the time limit. When the timer end, players assess the accuracy and stability of their towers. Afterward, they are ask to reflect on their experience during the game.

2.5. Data Analysis

The researchers analyzed the collected data using IBM SPSS (trial version) and Jamovi to evaluate the effectiveness of the intervention. Performance distribution was assessed through frequency counts and percentages, while mean and standard deviation calculations provided insights into average scores and variability across pre- and post-intervention assessments. To determine the statistical significance of score improvements, the Wilcoxon Signed-Rank Test—a nonparametric alternative to the paired *t*-test—was employed for within-group comparisons. Additionally, differences between the control and experimental groups were examined using the Mann-Whitney *U* Test, a nonparametric test for independent samples. To quantify the magnitude of these differences, rank-biserial correlation was calculated using Jamovi, providing an effect size measure for the nonparametric analyses. This comprehensive approach ensured robust evaluation of both statistical significance and practical relevance of the intervention outcomes.

2.6. Scoring Rubric

Students' performance in the Pre-test and Post-test was evaluated using the DepEd's standardized score interpretation framework (DepEd Memorandum No. 160, s. 2012), through statistical computation which adheres to the 60% passing mark (equivalent to a 75% grade). To further assess problem-solving accuracy and methodological consistency, Polya's strategy—particularly the calculation phase (carrying out the plan)—was incorporated, following the approach used in Paradesa's (2018) study on signed number operations. This dual assessment ensured alignment with DepEd benchmarks while also evaluating students' systematic problem-solving skills.

Table 1 - The Scoring Rubric of Mathematics Problem Solving Performance Following to Polya Strategy

Score	Interpretation
0	Not performing calculation
1	Performing the right procedure and probably produce a correct answer but miscalculate
2	Performing the right procedure and getting a correct answer

Table 2 - DepEd's score interpretation framework (DepEd Memorandum No. 160, Series of 2012)

Grading Scale (%)	**Equivalent Score**	**Interpretation**
90-100	35-42	Outstanding
85-89	32-34	Very Satisfactory
80-84	29-31	Satisfactory
75-79	25-28	Fairly Satisfactory
Below 75	Below 25	Did Not Meet Expectations

3. RESULTS AND DISCUSSIONS

This section presents the findings obtained from the research instrument, structured according to the study's objectives. The data are displayed through tables and figures that illustrate the mean pre-test and post-test scores, along with the statistical significance of performance differences in solving signed number problems.

3.1. Performance of the Respondents involving Signed Numbers

Table 3 – Pretest Results

	Group	**Grading Scale (%)**	**Equivalent Score**	**Frequency**	**Percentage (%)**	**Interpretation**
Pretest	Control	90-100	35-42	0	0	Outstanding
		85-89	32-34	0	0	Very Satisfactory
		80-84	29-31	0	0	Satisfactory
		75-79	25-28	0	0	Fairly Satisfactory
		Below 75	Below 25	8	100	Did Not Meet Expectations
	Mean= 13.88, Sd=2.85, Did not meet expectations					
	Experimental	90-100	35-42	0	0	Outstanding
		85-89	32-34	0	0	Very Satisfactory
		80-84	29-31	0	0	Satisfactory
		75-79	25-28	0	0	Fairly Satisfactory
		Below 75	Below 25	9	100	Did Not Meet Expectations

Mean= 13.33, Sd=2.83, Did not meet expectations

Table 3 shows the pretest results for both the control and experimental groups. Every participant scored poorly according to the learning expectations as demonstrated by the test results. The control group participants achieved scores under 75% as all eight participants (100%) were placed in the "Did Not Meet Expectations" rating category along with a mean score of 13.88 (SD = 2.85). All nine participants in the experimental group scored below 75% on the pretest which corresponded to "Did Not Meet Expectations" learning standards with an average of 13.33 (SD = 2.83). The research data shows no participation from students situated at or above the Fairly Satisfactory, Satisfactory or Outstanding achievement levels before initiating any instructional approach.

The parallel outcome scores between experimental and control groups confirm that participants started the experiment with comparable abilities thus maintaining study validity. Both groups started with similar performance levels (13.88 vs. 13.33) that showed moderate student performance variability based on their standard deviations.

Table 4 – Post Test Results

	Group	Grading Scale (%)	Equivalent Score	Frequency	Percentage (%)	Interpretation
Post Test	Control	90-100	35-42	1	12.5	Outstanding
		85-89	32-34	0	0	Very Satisfactory
		80-84	29-31	3	37.5	Satisfactory
		75-79	25-28	2	25	Fairly Satisfactory
		Below 75	Below 25	2	25	Did Not Meet Expectations
	Mean= 26.50, Sd=8.54, Fairly Satisfactory					
	Experimental	90-100	35-42	6	66.67	Outstanding
		85-89	32-34	1	11.11	Very Satisfactory
		80-84	29-31	1	11.11	Satisfactory
		75-79	25-28	0	0	Fairly Satisfactory
		Below 75	Below 25	1	11.11	Did Not Meet Expectations
	Mean= 33.56, Sd=6.69, Very Satisfactory					

Table 4 shows the post-test results of both groups. Both the control group and experimental group achieved different academic outcomes through their unique teaching methods in the post-instruction phase. The participants who received traditional instruction in the control group achieved better results post-test than at baseline yet their outcomes remained spread widely. Twelve and a half percent of students achieved Outstanding scores after the intervention and thirty-seven and a half percent demonstrated Satisfactory achievement while twenty-five percent received Fairly Satisfactory ratings. The control group showed that 25% of students did not achieve satisfactory levels although their mean score improved. As per the research results students taught through traditional methods scored 26.50 on average (SD = 8.54) in the Fairly Satisfactory zone showing a high amount of score variability because of variation in educational performance.

The students in the experimental group demonstrated exceptional outcomes after the class intervention took place. No less than 78.78% of students scored Outstanding or Very Satisfactory results during the intervention. The students who did not achieve expected results totalled only one out of nine (11.11%) while demonstrating significant improvement from pretest and control post-test results. Experimental participants who received the BINGO Number Tower Game achieved Very Satisfactory outcomes with an average score of 33.56 and standard deviation of 6.69. The BINGO Number Tower Game generated remarkable academic success among students with minimal outcome variation to match it.

3.2. Differences Between the Pre-Test and Post-Test in Solving Problems Involving Signed Numbers

Table 5 - Results for Mann-Whitney U test showing ranks

	Group	N	Mean Ranks	Sum of Ranks
Pretest	Control	8	8.75	70.00
	Experimental	9	9.22	83.00
	Total	17		

Analysis from Table 5 showed the Mann-Whitney U test compared the pretest results between the control group with 8 participants who achieved a mean rank of 8.75 and total ranks of 70.00 and the experimental group with 9 participants who obtained a mean rank of 9.22 and total ranks of 83.00. The experimental group achieved slightly higher mean ranks compared to the control group yet the results proved insignificantly different thus validating both groups' initial equivalence. Future observed differences will most likely stem from the intervention rather than preexisting elements because the test groups started with comparable results. Additional investigation of the p-value will show if the observed difference reaches statistical significance. Both research groups maintained similar levels at their pretesting phase.

Table 6 - Results for Mann-Whitney U test showing significant differences between Pretest scores

Group	Mann-Whitney U	Z	P-value	Decision
Control Experimental	16.000	-1.975	.054	The Null Hypothesis was Retained

Table 6 shows the Mann-Whitney U test compared pre-test scores between the control group (N = 8, Mean = 22.75, SD = 7.246) and the experimental group (N = 9, Mean = 34.89, SD = 3.756). Results (U = 16.000, Z = -1.975, p = .054) showed no significant difference at p < .05, so the null hypothesis was retained.

Table 7 - Results for Wilcoxon Signed-Ranked test showing negative and positive ranks

Group			N	Mean Ranks	Sum of Ranks
Control	Post Test-Pretest	Negative Ranks	0	.00	.00
		Positive Ranks	8	4.50	36.00
		Ties	0		
		Total	8		
Experimental	Post Test-Pretest	Negative Ranks	0	.00	.00
		Positive Ranks	9	5.00	45.00
		Ties	0		
		Total	9		

Table 7 shows the Wilcoxon Signed Rank Test results showed that all participants in both groups improved from pretest to post-test, with 0 negative ranks or unchanged scores. In the control group (n=8), the average positive rank was 4.50 (sum of ranks = 36.00). The experimental group (n=9) showed slightly stronger improvement, with an average positive rank of 5.00 (sum of ranks = 45.00). While both interventions were effective, the higher ranks in the experimental group suggest the Bingo Number Tower Game may have enhanced learning more than the control method. However, statistical significance depends on p-value verification.

The consistent improvements across all participants are notable, though the experimental intervention's marginally higher ranks indicate it could be more beneficial for signed number problem-solving. Further analysis is needed to confirm whether this difference is significant.

Table 8 - Results for Wilcoxon Signed-Ranked test showing significant differences between ranks

Group		N	Mean	Sd	Z	P-value	Decision
Control	Pretest	8	12.6250	1.76777	-2.527	.008	The Null Hypothesis was Rejected
	Post Test	8	26.5000	8.53564			
Experimental	Pretest	9	11.0000	1.32288	-2.668	.004	The Null Hypothesis was Rejected
	Post Test	9	34.8889	3.75648			

Table 8 shows the Wilcoxon Signed-Rank test was conducted to evaluate the differences between pretest and post-test scores for both the experimental group (N = 9) and the control group (N = 8). For the experimental group, pretest scores (M = 11.00, SD = 1.32) increased significantly at post-test (M = 34.89, SD = 3.76), with Z = -2.668, p = .004, leading to the rejection of the null hypothesis. The negative Z-value indicates that the ranks were assigned based on positive differences (post-test > pretest), meaning all participants improved, and there were no negative ranks or ties. This consistent improvement, supported by the significant p-value (p < .05), demonstrates the effectiveness of the intervention in the experimental group.

For comparison, the control group also showed significant improvement from pretest (M = 12.63, SD = 1.77) to post-test (M = 26.50, SD = 8.54), with Z = -2.527, p = .008. However, the experimental group's post-test mean (34.89) was notably higher than the control group's (26.50), suggesting that the intervention had a stronger impact on the experimental group.

The negative Z-values in both groups occur because the Wilcoxon Signed-Rank test calculates Z based on the sum of ranks, considering the direction of differences (post-test - pretest). Since all differences were positive (post-test > pretest), the test statistic is negative, reflecting consistent improvement in both groups. The significant p-values (p < .05) confirm that these improvements are statistically meaningful.

Evidently, while both groups improved significantly, the experimental group exhibited greater gains, highlighting the effectiveness of the intervention. The consistent positive differences and significant p-values underscore the success of the intervention in driving meaningful improvement.

A significant improvement was observed in the post-test scores measuring students' problem-solving abilities in the experimental group. This finding aligns with the study by Tella and Fatoki (2021), which demonstrated that the use of the Bingo game instructional strategy enhances students' problem-solving skills. Further support comes from Kailani, Newton, and Pedersen (2019), who emphasized that game-based learning approaches, such as the BINGO Number Tower Game (NTG), provide an effective framework for fostering problem-solving competencies.

Table 9 - Results for Mann Whitney U test showing ranks between Post Test Scores

	Group	N	Mean Ranks	Sum of Ranks
	Control	8	4.94	39.50
Post test	Experimental	9	12.61	113.50
	Total	17		

Table 9 shows the Mann-Whitney U test compared post-test scores between the control group (N = 8, mean rank = 4.94, sum of ranks = 39.50) and the experimental group (N = 9, mean rank = 12.61, sum of ranks = 113.50). The experimental group had significantly higher mean ranks, indicating better post-test performance compared to the control group. The substantial difference in mean ranks (4.94 vs. 12.61) and sum of ranks (39.50 vs. 113.50) suggests that the experimental group outperformed the control group at post-test. This result highlights the effectiveness of the intervention in improving outcomes for the experimental group. Further analysis of the Mann Whitney U statistic and p-value would confirm the statistical significance of this difference.

Table 10 - Results for Mann Whitney U test showing significant differences between Post Test Scores

Group	Mann Whitney U	Z	P-value	Decision
Control Experimental	3.500	-3.139	.001	The Null Hypothesis was Rejected

The Mann-Whitney U test revealed statistically significant superior performance in the experimental group compared to controls (Mann Whitney U = 3.500, Z = -3.139, p = .001), demonstrating the effectiveness of the Bingo Number Tower intervention. These findings align with Butler et al.'s (2003) research on Bingo's efficacy in enhancing mathematical achievement, while extending the evidence to signed number operations. The results further support constructivist frameworks (Tella & Fatoki, 2021) in mathematics education, showing measurable improvements in students' operational fluency through structured intervention.

Table 11- Results for the Effect Size of the Pre-post Test Scores

Statistic				P		Effect Size
Pretest (Experimental)	Post-test (Experimental)	Wilcoxon W	45.0	0.004	Rank biserial correlation	1.00

The Wilcoxon signed-rank test demonstrated a statistically significant improvement in scores from pretest to post-test for the experimental group (W = 45.0, p = 0.004). The perfect rank-biserial correlation coefficient of 1.00 indicated unanimous positive improvement across all participants, reflecting an exceptionally strong and consistent intervention effect. These results suggest the intervention was uniformly effective in enhancing student performance.

4. CONCLUSIONS AND RECOMMENDATIONS

First-year Bachelor of Elementary Education (BEED) students showed improved capabilities in solving signed number problems according to pre-test and post-test results following Bingo Number Tower Game (NTG) application. Results from the initial and follow-up testing showed the experimental group that applied NTG reached superior scores ("Very Satisfactory" mean = 33.56) beyond the control group's results ("Fairly Satisfactory" mean = 26.50). NTG led 66.67% of the experimental group to secure an "Outstanding" rating. Results from statistical analysis demonstrated the effectiveness of NTG by showing considerable post-test score differences ($p = .001$) alongside a very large effect size which indicates meaningful practical value in the improvement process. The experimental results confirm that using Bingo Number Tower Game enhances student performance in solving signed number problems.

The Commission on Higher Education (CHEd) should adopt the Bingo Number Tower Game (NTG) into math curricula according to the study conclusion to enhance signed number proficiency. Teachers should implement NTG as an abstract concept enhancer although researchers must test its performance with bigger groups across various mathematical subjects. Deadline participants take part in game-based activities which help them develop better problem-solving capabilities. The proposed steps create an effective learning environment in math classes. Research should extend to determine the program scalability toward various mathematical content and student ages alongside its results across different educational environments.

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