

Effectiveness of Cinco (Card for Improving Numeracy and Calculating Operations) As an Intervention for Grade 7 Mathematics Learners

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DOI: <https://doi.org/10.51244/IJRSI.2026.1306000501>

Received: 05 July 2026; Accepted: 10 July 2026; Published: 20 July 2026

ABSTRACT

Mathematics is essential in developing learners' logical reasoning and problem-solving abilities; however, many Grade 7 learners experience difficulties in numeracy and foundational algebra skills, particularly in solving linear equations. This study aimed to determine the effectiveness of the CINCO (Cards for Improving Numeracy and Calculating Operations) Card Game as an intervention to enhance the numeracy skills of selected Grade 7 learners at Sta. Cruz National High School. Specifically, the study identified learners' least mastered algebra competencies, developed a game-based intervention, and evaluated its effectiveness in improving academic performance. The study employed a quantitative research approach using a true-experimental pretest-posttest control group design. Thirty Grade 7 learners identified as not proficient in Mathematics through the Rapid Mathematics Assessment were selected through stratified random sampling and assigned to experimental and control groups. Data were collected using a researcher-made achievement test and analyzed through paired and independent t-tests. The CINCO Card Game consisted of 55 cards, including 25 problem cards, 25 answer cards, and 5 bonus cards designed to reinforce algebraic concepts through interactive learning. Results revealed a significant improvement in the post-test scores of learners in the experimental group compared to those in the control group. The findings indicate that the CINCO Card Game effectively enhanced learners' numeracy and problem-solving skills. Moreover, the study highlights the value of game-based learning in increasing student engagement, motivation, and achievement in Mathematics. The CINCO Card Game is therefore recommended as an effective instructional intervention for strengthening foundational algebra skills among struggling Grade 7 learners.

Keywords: Numeracy, card game, learning intervention, calculating operations, mathematics.

INTRODUCTION

Mathematics is a fundamental discipline that develops learners' logical reasoning, problem-solving, and analytical thinking skills. Despite its importance, many Grade 7 learners continue to struggle with basic numeracy and algebraic concepts, particularly in solving linear equations in one variable. This challenge becomes more evident as learners transition from arithmetic to abstract algebraic reasoning. National and local assessments have consistently shown low mathematics performance among Filipino learners. Results from the 2022 PISA and reports from the Philippine Institute for Development Studies (2021) highlighted the need to strengthen foundational numeracy skills to prevent long-term learning difficulties. At Sta. Cruz National High School, the Albay Numeracy Assessment Tool (ALNAT) and Rapid Mathematics Assessment (RMA) revealed that many Grade 7 learners remain at the Needs Major Support and Emerging proficiency levels in Mathematics. Among the identified competencies, solving linear equations in one variable was selected as the focus of this study due to its importance in developing algebraic thinking and problem-solving skills. Research suggests that game-based learning can increase student engagement, motivation, and academic achievement. However, limited studies have explored its effectiveness in improving the numeracy skills of struggling learners. To address this gap, this study sought to answer the following research problems: 1) What are the least learned

competencies in Algebra among selected Grade 7 learners of Sta. Cruz National High School; 2) What card game can be developed as an intervention to selected Grade 7 learners; and 3) What is the effectiveness of the developed card game to the academic achievement of selected Grade 7 learners in terms of test scores difference? The null hypothesis of the study is there is no significant difference in the pretest and posttest scores between the experiment and controlled groups.

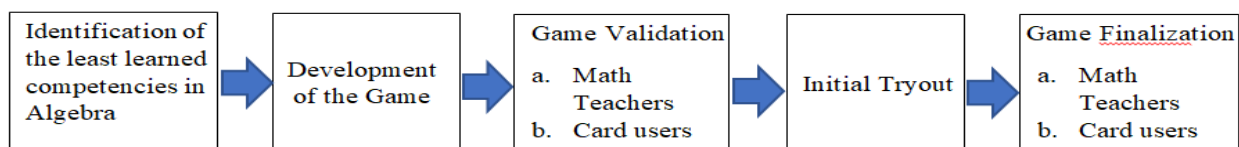
MATERIALS AND METHODS

The study applied Modified Research and Development Model of Gall et al., used in the study of Singh et al. (2021) and Gustiani (2019) along with quasi-experimental research design. This two-phased study involves the development phase of CINCO card game and the second phase involves the execution of the card game with the respondents.

A. Development of the CINCO Card Game

The Research and Development Model has been used to establish systematic process of the development, validation, evaluation and finalization of the CINCO card game. This process is illustrated in Figure 1.

Figure 1. CINCO Card Game Development Process



Steps 1 and 2 involved internal validation, which commenced from the identification of the least learned competencies in Algebra to the conceptualization of the Math Card Game. Meanwhile, Steps 3 to 5 involved external validation in collaboration with experts and initial card users. The development of the math card game was done for three months. The specific process was as follows:

Step 1: The researchers identified the least learned competencies from the ALNAT results of Grade 7 learners.

Step 2: The Math Card Game and its guide mechanics were designed and developed.

Step 3: The game was validated for content, face validity, and efficiency, with input from mathematics teachers, the research adviser, and student play-testers.

Step 4: The CINCO Card Game underwent an initial tryout of five rounds with the student validators.

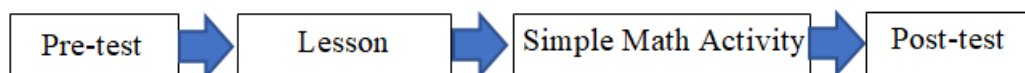
Step 5: Feedback from teachers and students was used to refine and finalize the game and its materials.

In the second phase of the study, a one-group pretest-post test quasi-experimental research design is applied to administer the developed CINCO Card Game and determine the effectiveness of the card game to the academic achievement of the Grade 7 non-numerates in Sta. Cruz National High School in School Year 2025-2026 through test scores difference. The main instrument used for this study aside from the materials for CINCO Card Game was the researcher-made achievement test that measured the conceptual understanding and computational skills in Algebra of the selected Grade 7 learners. The achievement test is a multiple-choice test consisting of 30 items involving Algebraic concepts particularly solving linear equations. The said tool was validated by three Mathematics teachers who are experts the field and have rich experiences in research tool validation. The process of the use of the developed game and the traditional method of learning Algebra is shown in Figures 2 and 3.

Figure 2. Experimental Group



Figure 3. Control Group



The recently conducted Rapid Mathematics Assessment (RMA) 2025 in Sta. Cruz National High School results showed that the learners enrolled in Grade 7 were in need of learning intervention in Algebra. From the complete list of 106 enrolled Grade 7 learners in School Year 2025-2026, only 30 respondents were selected by the researchers through the stratified random sampling technique, where each section was treated as a stratum. The selected respondents were then randomly divided into two groups: the experimental group and the control group, with 15 members each.

To analyze the data, the researchers used a paired t-test to determine the significant difference between the pre-test and post-test scores within each group. An independent t-test was also employed to compare the mean scores of the experimental and control groups before and after the intervention. Finally, a comparative analysis was conducted to examine differences in performance between the experimental group exposed to the CINCO Card Game and the control group that received traditional instruction. This analysis determined whether the CINCO Card Game significantly improved learners' numeracy performance.

Figure 4. Independent T-Test

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

Figure 5. Paired T-Test

$$t = \frac{\bar{d}}{S_d / \sqrt{n}}$$

DISCUSSION OF RESULTS AND FINDINGS

Least Learned Competencies in Algebra among Grade 7 Learners

The study identified the least learned competencies in Mathematics, particularly in Algebra, among 101 Grade 7 learners at Sta. Cruz National High School using the Albay Numeracy Assessment Tools (ALNAT) 2024. Based on these results, the competencies with the lowest mean scores were determined as the least learned, providing a basis for identifying areas where students need the most support.

Table 1. Least Learned Competency based on the SCNHS ALNAT 2024 Results

COMPETENCY	AVERAGE	RANK
Determine the measures of angles and the number of sides of polygons	44.26	1
Perform operations on rational numbers	40.15	2
Organize statistical data in a frequency distribution table	30.30	3
Solve one variable in terms of the other variables in a formula	29.17	4
Multiply and divide integers	28.57	5

Find the value of an unknown in an equation where the unknown is non-negative	22.44	6
Find the volume of a cylinder	14.29	7
Simplify numerical expressions involving integers using number properties and the order of operations (GEMDAS)	4.11	8

The data in Table 1 shows that Grade 7 learners performed strongest in geometry and rational number competencies, with the highest mean score in determining the measures of angles and the number of sides of polygons (44.26, Rank 1) and performing operations on rational numbers (40.15, Rank 2), indicating solid understanding of these concepts. Moderate performance was observed in organizing statistical data, solving one variable in terms of another in a formula, and multiplying and dividing integers. Lower scores were recorded in solving equations with non-negative unknowns and finding the volume of a cylinder (14.29, Rank 7), suggesting difficulties in algebraic and geometric applications. The weakest area was simplifying numerical expressions involving integers using number properties and the order of operations (GEMDAS), which obtained the lowest mean score of 4.11 (Rank 8), reflecting very limited mastery of numerical simplification skills. Overall, the results indicate that students are more proficient in basic geometry and rational number operations but face challenges in multi-step problem solving, algebraic manipulation, and the application of mathematical formulas.

The findings indicate that while learners performed relatively well in geometry and rational numbers, they encountered difficulties in algebraic manipulation, numerical expressions, and formula application. Consequently, Algebra, particularly Linear Equations, was selected as the focus of this study because it was identified as one of the least learned competencies, with "Finding the Value of an Unknown in an Equation where the Unknown is Non-negative" obtaining an average score of 22.4 (Rank 6). This is in consonance with the study by Bosque (2025) who found out that many students consistently struggle with linear equations and inequalities. This competency is also part of the current Grade 7 mathematics curriculum at Sta. Cruz National High School. Strengthening learners' algebraic foundations at this level is essential, as these concepts serve as prerequisites for more advanced mathematical learning.

The findings suggest that instructional interventions should prioritize strengthening students' skills in algebraic processes, numerical expressions, and formula application. Consequently, Algebra—particularly Linear Equations—was selected as the focus of this study because it was identified as one of the least learned competencies, with learners obtaining a mean score of 22.44 (Rank 6) in finding the value of an unknown in an equation. This topic is also currently taught to Grade 7 learners at Sta. Cruz National High School and serves as a fundamental prerequisite for higher-level mathematics. These findings are supported by the study of Erbas et al. (2009), which found that students struggle with linear equations due to conceptual misunderstandings, misuse of mathematical rules, and computational errors. The study emphasizes that solving linear equations requires the integration of conceptual, procedural, and arithmetic skills, highlighting the need for targeted instructional strategies to improve students' mastery of algebraic concepts.

Card Game Developed As An Intervention To Selected Grade 7 Learners

CINCO is intended to develop mastery of computational skills in Linear Equations in Grade 7 Algebra. The goal of each player is to gain the highest score to win the game.

Number of Players: 2 to 4 players in a group

Content: Solving values of x in Linear Equations

Cards in the Deck:

- Problem cards (25 PCs); containing linear equations
- Answer cards (25 PCs); contain answers to linear equations

- Bonus cards (5 pcs); give special advantages (e.g., “+5 points”)

Skills developed: Computational skills of solving the values of x in Linear Equations

Goal of users: Solve the value of x of linear to match the cards and earn the highest score.

Scoring System: Each correct pair has a corresponding 5 points. The bonus cards will also be added to the score.

A. Mechanics to Play CINCO Card Game

Determining the First Player: The facilitator shuffles the cards and distributes four (4) problem cards to each player. All players will draw one card each from the Draw Pile placed at the center. The player who got the highest number Answer Card will be the first to play and follows clockwise sequence from the first player for their turns.

For the first player:

1. The first player will draw one (1) card from the Draw Pile.
 2. The player will check if they have the corresponding Problem Card in their hand.
 3. If yes, they will place the matching cards face up on the table.
 4. The facilitator will check if the answer is correct.
 - If correct, the player earns 5 points and the pair will be placed in the Completed Pile.
- After scoring, the player may draw another card from the Draw Pile.
 - The player will then check if they have the matching Problem Card for the new Answer Card.
 - If yes, they will place the pair face up, and if correct, earn another 5 points.
 - If no, the drawn Answer Card will be passed to the next player.
 - If incorrect, both cards are taken back into the player's hand.
 - If the player still has no matching pair, they will draw one Problem Card from the facilitator's hand.
 - The drawn Answer Card will then be passed to the next player.

For the next player's turn:

1. The next player will check if they have the Problem Card that matches the Answer Card passed to them.
2. The player will check if they have the corresponding Problem Card in their hand.
3. If yes, they will place the matching cards face up on the table.
4. The facilitator will check if the answer is correct.

Ending the Game: The game ends when one player has no cards left or the Draw Pile runs out of cards. With other players still having the other cards, they will receive score deductions of 2 points for each Problem Card.

Winning the Game: At the end of the game, each player's total points are added up, and first player to use all their cards receives an additional 25 bonus points. Deductions are then made for any remaining cards still held by the players. The player with the highest final score after this adjustment is declared the winner of CINCO.

Effectiveness of Cinco Card Game in Improving the Academic Performance of Grade 7 Learners

The Table 2 shows the results of Independent T-test and Paired T-test of the pre-test and post-test of both Experimental and Controlled group as well as the comparative analysis of the pre-test and post-test results of both groups to determine the significance of difference in their scores.

Table 2. Independent T-test of Experimental and Controlled Group (Pre-test) Two-Sample Assuming Equal Variances

Variable	Group	N	Mean	Std. Dvn.	T-test Statistics	Df	p-value (2-tailed)
Pre-Test	Experimental Group	15	13.2	5.21	1.938	28	0.0573
	Controlled Group	15	10.2	2.68			

The pretest results showed that the Experimental Group ($n = 15$) obtained a mean score of 13.20 ($SD = 5.21$), while the Control Group ($n = 15$) achieved a mean score of 10.20 ($SD = 2.66$). Although the Experimental Group recorded a slightly higher mean score, an independent-samples t-test revealed that the difference was not statistically significant, $t(28) = 1.938$, $p = 0.0573$. Since the p -value exceeded the 0.05 level of significance, the null hypothesis was retained. These findings indicate that both groups had comparable levels of prior knowledge and mathematical skills before the intervention. Therefore, any differences observed in subsequent assessments may be attributed more confidently to the intervention rather than to pre-existing differences between the groups.

Table 3. Independent T-test of Experimental and Controlled Group (Posttest) Two-Sample Assuming Equal Variances

Variable	Group	N	Mean	Std. Dvn.	T-test Statistics	Df	p-value (2-tailed)
Post-Test	Experimental Group	15	18.53	3.58	4.12	28	0.0003
	Controlled Group	15	12.40	4.52			

The data statistically shows that the means of the post-test results of the Experimental and Controlled Group vary significantly with the values of 18.53 and 12.40 respectively. And with the t-statistics value of 4.12 and p -values for two-tailed test of 0.0003 that is less than the alpha level of 0.05, implies that there is a significant difference between the post-test scores upon using the developed card game and traditional teaching method, although discussion of solving linear equations are disseminated towards both groups. This indicates that there is a change in the level of mathematical skills of both groups, particularly the Experimental group who received the CINCO card. The results then reject the null hypothesis, indicating that there is a significant difference between the experimental and controlled group.

Table 4. Pretest and Posttest Paired T-test Results of Control and Experimental Group

Group	Variable	N	Mean	Std. Dvn	Std. Error Mean	Df	p-value (2-tailed)	Sig. (2-Tailed)
Control Group	Pre-test	15	10.20	5.21	~1.182	14	0.0843	2.145

	Posttest		12.40	12.40				
Experimental Group	Pre-test	15	13.20	5.21	~1.254	14	0.00081	2.145
	Posttest		18.53	3.58				

Table 4 shows that the control group had no significant improvement between the pre-test ($M = 10.2$) and post-test ($M = 12.4$), as indicated by a t -value of 1.86 and a p -value of 0.0843 (> 0.05). In contrast, the experimental group demonstrated a significant increase in performance, with mean scores rising from 13.2 to 18.53, supported by a t -value of 4.25 and a p -value of 0.00081 (< 0.05). These findings reject the null hypothesis and confirm that the CINCO Card Game was an effective learning intervention that significantly improved learners' performance.

Table 5. Comparative Analysis of Pre-test and Posttest Scores of Experimental and Control Group (Independent)

Variable	Experimental group	Controlled group	Mean Gain	T-value	p-value (two-tailed)	Interpretation
Pre-test	13.20	10.2	3.00	1.9827	0.0573	Not Significant
Post-test	18.53	12.40	6.43	4.1203	0.0003	Significant

Table 5 shows that there was no significant difference between the experimental and control groups in the pre-test, as the experimental group ($M = 13.20$) and the control group ($M = 10.20$) had a p -value of 0.0573 (> 0.05), indicating that both groups were comparable before the intervention. However, the post-test results revealed a significant difference, with the experimental group obtaining a higher mean score ($M = 18.53$) than the control group ($M = 12.40$), supported by a t -value of 4.1203 and a p -value of less than 0.05. These findings reject the null hypothesis and indicate that the use of the CINCO Card Game significantly improved the mathematical skills of learners in the experimental group compared to those in the control group.

Table 6. Comparative Analysis (Paired T-test) of Pretest and Posttest Scores of Experimental and Control Group

Group	Pre-test Mean	Posttest Mean	Mean Gain	T-value	p-value (two-tailed)	Interpretation
Experimental (CINCO)	13.20	18.53	5.53	~4.2459	0.00081	Significant
Control (Traditional)	10.20	12.40	2.20	~1.8581	0.0843	Not Significant

The results of changing in the level of mathematical skills is more evident in the results of the Experimental group, who received the CINCO card game. This finding is evidenced in the results of the Comparative Analysis of the Paired t -test of both group in the Table 6, it shows that the Experimental group exposed to the CINCO card game obtained a higher mean gain (5.53) compared to the controlled group (2.20). The paired-test results further indicate that the improvement in the experimental group is statistically significant ($p < 0.05$), while the improvement in the controlled group is not statistically significant ($p > 0.05$). This implies that there was an improvement in the level of mathematical skills of the Experimental group after the CINCO card intervention justifying that the card game helped the learners improve their mathematical skills in solving linear equations.

The comparative analysis on the paired t -test results of the Experimental group implies that engaging learners in an active, enjoyable and challenging learning experiences through group activities such as the CINCO card game supervised by teacher or peers as facilitator creates learning as evidenced in its significant mean gain in pretest and posttest results. This result is similar to the study by Sulpico et al. (2025) and Nasir et al. (2020) whose findings showed a statistically significant increase in post-test scores and learning numeracy among the respondents. The use of such games transforms the traditional teaching method into an environment where students are more engaged and motivated. (Munda et al., 2024; Coronacion, 2024; Fadholi et al., 2025). Because

when learners enjoy the learning process, their anxiety toward Mathematics decreases, and their confidence increases.

This finding highlights several important implications regarding the use of the CINCO card game and other game-based strategies in mathematics instruction. First, integrating card games into classroom instruction can serve as an effective supplementary strategy to traditional teaching methods. Games such as CINCO provide opportunities for repeated practice of algebraic equations in a non-threatening and motivating environment. This reduces mathematics anxiety and increases learner engagement, which are essential factors in improving academic performance. (Lomibao et al., 2024). Second, the collaborative nature of card games fosters peer interaction, critical thinking, and problem-solving skills (Mahato, 2025; Quentin, 2023). When learners explain their reasoning and challenge one another's answer, they construct knowledge more effectively. Third, the structured supervision of teachers or peer facilitators ensures that the learning objectives remain aligned with curriculum standards while maintaining the fun and interactive elements of the activity (Nisbet, 2024). This positive atmosphere, where it highlights joy, fun and engagement can help to have a better outcome of the learning process (Rosete et al., 2023).

Additionally, the CINCO Card game can be adapted not only to the targeted competency but also to the other Mathematics competencies such as operations on integers, fractions, basic fundamental and algebraic expression. Also, similar-game based can also be applied in other subject areas such as Science for matching concepts and definition, in English for vocabulary development and grammar exercise and other fields. Because the structure of game promotes engagement, collaboration, and active participation, it can be an effective pedagogical approach across different subject areas.

These results are also supported by the findings of the locally-conducted studies of Singh et al. (2021) and Lagmay et al. (2024), whose findings revealed that math card game significantly impact mathematics learning and that is highly effective in enhancing numeracy computation skills in math as well as enhancing attitude toward learning mathematics. The respondents have expressed benefits in using CINCO in their Math learning not solely on improving their cognitive and practical skills in computing linear equations but also sparked their excitement in learning math since they were playing and learning as a group

This also echoed the findings that game-based mathematics learning has significant effects on learners' academic achievement under the same research methodologies and design. And that among the card-based learning methods in mathematics, card sort has the highest influence that impacts mathematical learning (Solehah et al., 2024). This finding is relevant to the current study as it employed card sort type of math card game in learning algebraic equations in Grade 7 and is known to significantly enhanced mathematics learning of the Grade 7 learners, as one of the respondents said, "*masaya kasi may mga kasama ako maglaro habang nag-aaral ng math*" (I am happy to learn math while having fun with other players). Others also shared that they were challenged while having fun in playing the game, "*Masaya pero mahirap din kasi kailangan magcompute muna...*" (it was fun but challenging at the same time since we have to compute the math equations). Others also praised the game, "*Nag-enjoy ako kasi nadagdagan ang kaalaman ko sa math na ganun pala i-solve at super galing ng laro namin!*" (I enjoyed a lot since I learned how to solve [linear equations] and did great in the game!).

The researchers attribute this impact in gradually developing the learner's academic performance in stages (rounds) with the right academic support from teachers, peers or adults (scaffolding). Learners who actively play the card game integrates mathematical concepts in problem-solving situation in a fun and interactive manner which eventually translates these experiences into a meaningful learning and exploration with their peers. These accentuate Piaget's Constructivism Theory, Kolb's Experiential Learning Theory and Vygotsky's Zone of Proximal Development (ZPD) and scaffolding which this study is anchored upon. These theories emphasized that learners are capable of constructing their own learning and best accomplished when aided with learning support from an adult or peers capable of helping them reached higher levels of learning through mentoring or meaningful learning experiences.

CONCLUSION

Based on the findings of the study, the following conclusions are made:

1. The findings of the study revealed that one of the least competencies in Grade 7 Algebra is computing algebraic equations, as reflected in ALNAT results.
2. CINCO (Card for Improving Numeracy and Calculating Operations) is a math card-sorting game for 3–4 players that helps learners practice algebraic equations. It uses probability in selecting equations and includes 55 cards: 25 equation cards, 25 matching answer cards, and 5 bonus cards. Multiple groups can play at the same time if enough card sets are available.
3. The CINCO Card Game is an effective learning intervention that significantly improves the mathematical performance of Grade 7 learners at Sta. Cruz National High School, as shown by the experimental group's higher post-test scores after using the game.

ACKNOWLEDGEMENTS

The researchers sincerely express their gratitude to the students who participated as respondents in this study. They also extend their appreciation to the members of the Sta. Cruz National High School Research Committee, the School Head and the jurors of the Municipal and Division Math Fair for their valuable feedback, constructive criticism, and insightful recommendations. Their guidance and support contributed significantly to the refinement of the research process and the enhancement of the study's outputs and findings.

Conflict Of Interests

The researchers declare no conflict of financial, personal, professional or institutional interest during the conduct of the study that could have influenced the research process, analysis or reports of the study. The study was carried out objectively and in strict compliance with ethical research procedures.

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