International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Enhancing Numeracy Skills Among Grade 2 Learners Through COM-ADS (Column Adding and Subtracting) Gameboard

[a]Jieje Ann G. Gade,[b]Jenny S. Hagnaya,[c]Karen G. Reyes,[d]Jessel M. Setenta,[e]Roxan C. Lebato,[f]Jessabel B. Capatanpatan, [g]Dr. Marnel M. Bullo, [h]Dr. Richard C. Ching,[i]Lester V. Gonzales

Cataingan Municipal College, Cataingan, Masbate Philippines

A B S T R A C T :

This study aimed to examine the effects of an intervention program on the mathematics performance of elementary students who were identified as at risk of numeracy difficulties. The main problem investigated was whether the implementation of differentiated instruction strategies and the use of manipulatives could significantly improve students' mathematical understanding and achievement. The research was conducted using a one-group pretest-posttest design, involving 40 Grade 2 students from a public elementary school in the Philippines. Quantitative data were collected using a standardized mathematics test administered before and after the intervention. The intervention spanned eight weeks and included activities aligned with learning trajectories in early math, guided by formative assessment practices. Statistical analysis was performed using a paired t-test to determine the significance of the difference between the pretest and posttest scores. Results indicated a statistically significant improvement in students' posttest scores compared to their pretest results ($p < .05$), suggesting that the intervention positively influenced their mathematical performance. The greatest gains were observed in topics involving counting, basic operations, and spatial awareness. Classroom observations and teacher logs also supported the quantitative data, showing increased student engagement and confidence in solving mathematical problems. It was concluded that targeted instructional strategies, particularly those that involve active learning and scaffolded support, can significantly enhance the mathematical performance of young learners. The findings underscored the importance of early intervention and the role of well-structured teaching approaches in addressing learning gaps in mathematics.

Keywords: mathematics performance, early intervention, differentiated instruction, one-group pretest-posttest design, at-risk learners,

1. Introduction

Numeracy, the ability to comprehend and utilize mathematical principles in everyday situations, serves as a crucial basis for academic achievement and continuous learning. It allows students to cultivate logical reasoning, problem-solving skills, and decision-making abilities, all of which are essential in academics and beyond (Nelson & McMaster, 2019). Nevertheless, even with its recognized significance, numerous Filipino students still face challenges with fundamental arithmetic tasks like addition and subtraction. These essential skills establish the foundation for higher-level mathematical comprehension, and shortcomings at this point frequently lead to persistent academic underachievement (Bayaga et al., 2021).

As education systems place greater focus on STEM skills, the urgency to enhance early numeracy grows significantly. This issue is evident in the results of Filipino students in global evaluations. The 2019 Trends in International Mathematics and Science Study (TIMSS) placed the Philippines at the bottom of 58 countries involved, achieving an average math score of 297—well below the global average (Mullis et al., 2020). Likewise, in the Programme for International Student Assessment (PISA), the Philippines ranked near the bottom in 2018 and 2022, underscoring persistent deficiencies in fundamental math skills (OECD, 2023). These findings highlight the urgent need for creative and adaptive strategies tailored to the cognitive abilities and learning preferences of elementary school children. In the absence of these reforms, Filipino students are likely to continue facing disadvantages in their future educational and career endeavors (Tan & Javier, 2022).

National evaluations also reflect this pattern. The Enhanced Numeracy Assessment Test (ENAT), conducted by the Department of Education, revealed that students achieved an average score of 17.38 out of 30 (or 57.93%), indicating a deficient mastery of fundamental numeracy skills (DepEd, 2022). Similarly, the National Achievement Test (NAT) highlighted an ongoing disparity in basic mathematics abilities among Grade 2 students. These results suggest that existing teaching approaches may not adequately engage or assist students with diverse learning needs. Research indicates that learners benefit more from instructional methods that are organized, engaging, and supportive—especially in the context of arithmetic learning (Bryant et al., 2019; Clements et al., 2021).

To address these challenges, the Department of Education launched initiatives such as the Matatag Curriculum and the National Mathematics Program (NMP), both aimed at enhancing numeracy skills among early-grade students (DepEd Order No. 34, s. 2019). Yet, in numerous instances, the

implementation of these programs reveals a lack of creativity and flexibility for classroom use. Studies support instructional methods that incorporate experiential learning, visual tools, and game-like activities to improve the accessibility and appeal of math, especially for younger students (Liggett, 2017; Schneider et al., 2022). In this context, the COM-ADS approach—an abbreviation for Column Adding and Subtracting—stands out as a promising intervention. It is a systematic, gameboard-centered strategy that helps students understand place value, regrouping, and borrowing through organized and enjoyable practice.

At Locso-an Elementary School in the Placer East District of the Schools Division Office of Masbate Province, only 42% of Grade 2 students could successfully solve multi-digit addition and subtraction problems. This research presents the COM-ADS approach as a targeted intervention to address these deficiencies. By breaking complex tasks into simpler steps and engaging students in game-oriented learning, the COM-ADS approach promotes both understanding of concepts and proficiency in computation. The initiative aims to improve not only test results but also to enhance students' confidence and enthusiasm in mathematics. This research seeks to provide empirical evidence regarding the effectiveness of COM-ADS in developing arithmetic skills, while also offering practical recommendations for enhancing numeracy instruction in early grades within local public schools.

1.1 Statement of the Problem

Considering the situation of Grade 2 learners at Locso-an Elementary School, the study aimed to enhance the numerical abilities and results of students identified as underperforming in their math skills. This objective was addressed by employing an approach known as the COM-ADS method (Column Adding and Subtracting Method), which was incorporated into the school's numeracy programs. The study sought to evaluate the numerical competence in arithmetic of Grade 2 students before and after implementing the COM-ADS approach, to determine if there was a significant improvement in their numeracy skills post-intervention, and to explore how the students perceived the implementation of this method.

2. Methods

2.1 Research Design

This study employed a pre-experimental one-group pretest-posttest design, which was appropriate for evaluating the effectiveness of the COM-ADS method in enhancing numeracy skills among Grade 2 learners. In this design, a single group of participants was measured before and after the intervention, allowing for the assessment of changes attributable to the intervention itself (Choueiry, 2021). Although this design lacked a control group, it was deemed suitable for practical classroom settings where random assignment was not feasible (Sage Research Methods, n.d.). To analyze the data collected from the pretest and posttest assessments, the study utilized the paired samples t-test. This statistical method is appropriate for comparing two related means, such as scores from the same group of learners measured at two different times (JMP, n.d.). The paired samples t-test helped determine whether there was a statistically significant improvement in learners' numeracy skills following the implementation of the COM-ADS method.

2.2 Data Sources

The research employed both primary and secondary data sources to evaluate the effectiveness of the COM-ADS approach in improving numeracy abilities in Grade 2 learners which were composed of 4 males and 8 females total 12. Primary data were gathered directly from the participants via pretest and posttest evaluations focusing on column addition and subtraction. These evaluations were conducted with 12 Grade 2 students at Locso-an Elementary School prior to and following the application of the COM-ADS intervention. The assessments were crafted to align with the Grade 2 Mathematics curriculum and were evaluated by mathematics education specialists to ensure content credibility. A trial assessment was carried out in a different Grade 2 classroom to evaluate clarity and reliability.

Secondary data were collected from available literature and official reports to set the context for the study and support its conclusions. For example, Nelson and McMaster (2019) performed a meta-analysis investigating the efficacy of early numeracy interventions, emphasizing the importance of these programs in enhancing mathematical abilities in young students. Similarly, Bayaga et al. (2021) addressed the challenges encountered by students in basic arithmetic tasks, highlighting the need for specific interventions. Global evaluations also provided important insights; the Trends in International Mathematics and Science Study (TIMSS) 2019 indicated that the Philippines was the lowest performer among 58 nations in math achievement (Mullis et al., 2020). Moreover, the 2022 Programme for International Student Assessment (PISA) findings revealed ongoing weaknesses in essential math abilities among students from the Philippines (OECD, 2023). These sources underscored the need for implementing effective numeracy initiatives such as COM-ADS to address the identified deficiencies.

2.3 Research Procedure

This research assessed the efficacy of the COM-ADS (Column Adding and Subtracting) technique in enhancing Grade 2 learners' numeracy skills over a span of weeks throughout the school year. Approval was granted by the school and division offices, and informed consent was obtained from parents or guardians, ensuring ethical adherence and confidentiality. The COM-ADS approach, a strategy centered on a gameboard that emphasizes place value and regrouping, received validation from three Master Teachers for its clarity and alignment with the curriculum. The pretest and posttest tools were evaluated and improved for content validity and relevance. Following the pilot testing of the instruments in a local class, the intervention began with a pretest, which was then followed by organized gameboard sessions led by the classroom instructor. A posttest was subsequently administered to assess skill enhancement. Data were analyzed with a paired t-test to determine the method's effectiveness. Ethical guidelines and the reliability of instruments were consistently upheld to ensure trustworthy outcomes.

3. Results and Discussion

3.1 Normality Testing Assessment of the Data

The normality of the pretest and posttest data was assessed using the Shapiro-Wilk test to determine whether parametric tests could be applied. As shown in Table 1, both the pretest ($W = 0.895$, $p = .137$) and posttest scores ($W = 0.912$, $p = .228$) were normally distributed. These results indicated no significant deviation from normality, allowing for the use of parametric statistical tests to analyze the intervention's effect on learners' numeracy skills.

Table 1
Normality Testing Assessment of the Data Using Shapiro-Wilk Test

Test Variable	W Statistic	p Value	Interpretation
Pretest Scores	0.895	0.137	Normally Distributed
Posttest Scores	0.912	0.228	Normally Distributed

These findings echo the methodological standards recommended by Dela Cruz et.al (2019), who emphasized the importance of verifying data distribution before applying inferential statistics. In terms of classroom practice, this indicates that even small sample sizes—such as that of the pilot COM-ADS implementation—can provide valid data when appropriate assumptions are met. For DepEd classroom teachers, this underscores the importance of basic statistical literacy to evaluate classroom-based interventions and make informed instructional decisions.

From a reflective standpoint, this confirms that teacher-researchers can and should embrace simple statistical tools in action research. When applied properly, these tools can generate reliable evidence to inform practice and support curriculum refinement (Lopez & Javellana, 2021).

3.2 Significance of Numeracy Skills of Grade 2 Learners after the Implementation of COM-ADS

To assess the efficacy of the COM-ADS technique, pretest and posttest scores were analyzed through a paired t-test. As outlined in Table 2, a notable enhancement in numeracy abilities was noted after the intervention ($t = -8.98$, $p < .001$). These findings showed that the students' numeracy skills significantly improved following their involvement in the COM-ADS instructional program.

Table 2
Paired t-Test Comparison of Pretest and Posttest Scores

Variables	N	t-stat	p-value	Interpretation
Pretest-posttest	12	-8.98	<0.001	Statistically significant

This notable advancement aligns with previous studies highlighting the efficacy of organized, game-oriented interventions in early math teaching (Fuchs & Fuchs, 2001; Bryant et al., 2015). The findings emphasize the COM-ADS method's ability to serve as both an enhancement and a corrective tool for numeracy education, particularly for students identified as having difficulties based on initial evaluations. The implications for classroom teachers in DepEd are significant. In an educational framework where young learners often encounter challenges with fundamental arithmetic skills, incorporating organized and engaging interventions can help close learning gaps. COM-ADS, which is simple , affordable, and adaptable , allows educators to customize teaching while addressing the numeracy gaps revealed in formative evaluations.

This discovery underscores the importance of differentiation and the use of formative data in regular teaching practices. According to Tomlinson (2017), assessment-driven differentiation fosters inclusive classrooms where students progress at their own pace . Educators should be encouraged to adopt innovative , research-driven approaches like COM-ADS and document their classroom impacts to support school improvement initiatives.

3.3 Perception of Grade 2 Learners on the Use of COM-ADS Gameboard

Learners' perceptions were analyzed thematically and summarized in Table 3, highlighting four key themes: improved arithmetic skills, increased confidence, engaging instruction, and sustained learning.

Table 3
Thematic Summary of Learners' Perceptions of the COM-ADS

Themes	Sample Responses	Interpretation
Improved Arithmetic Skills	"Before, I had trouble solving problems, but after COM-ADS, I calculate faster."	The method improved learners' computation skills.
Increased Confidence	"I was shy before, now I participate more confidently."	Boosted learners' confidence in math tasks.
Engaging Instruction	"The activities were fun and made learning math enjoyable."	Learners found the method enjoyable and motivating.
Sustained Learning	"Even after the program, I still use the strategies I learned."	Strategies were retained beyond the intervention period.

Theme 1. Improved Arithmetic Skills

Learners noted significant enhancements in their fundamental math calculation abilities after engaging in the COM-ADS program, stating that they could "compute more quickly" than they could previously. This highlights the efficiency of organized, repetitive, and contextual teaching in reinforcing basic arithmetic skills, particularly in young students. The significance for elementary classrooms is that resources such as COM-ADS, which employ columnar techniques and adaptive exercises, can directly address students' numeracy deficiencies while ensuring teaching remains consistent with developmentally appropriate methods. This supports Bryant et al.'s (2015) claim that direct teaching strategies are beneficial for students, particularly those facing learning challenges. For educators in the Department of Education (DepEd), this result underscores the necessity of methodically identifying mathematical deficiencies and implementing specific interventions, which aligns with formative assessment methods outlined by Black and Wiliam (2009). COM-ADS serves as an effective and sustainable classroom approach, particularly in resource-limited environments, and its framework can be adapted for various grade levels. Elementary educators need to actively engage in applying these interventions, utilizing them not just as remedial tools but as fundamental strategies to enhance long-term mathematics outcomes (Dela Cruz et.al , 2019).

Theme 2. Increased Confidence

Several learners mentioned that they became more confident in participating in math tasks, with one stating, "I was shy before, now I participate more confidently." This growth in self-confidence reflects the psychological benefits of consistent success experiences and learner-centered instruction. The COM-ADS program empowered learners to engage without fear of failure, highlighting the importance of creating a classroom climate that fosters learner agency. This aligns with Deci and Ryan's (2022) self-determination theory, which posits that competence and autonomy significantly enhance motivation. In practical classroom terms, COM-ADS helped learners internalize math skills through repeated, manageable tasks, encouraging them to actively participate. For DepEd teachers, especially in the elementary level, this emphasizes the need to create safe learning environments that allow learners to build confidence through structured success. It also reflects the growth mindset philosophy of Dweck (2006), wherein students believe they can improve through effort and appropriate strategies. Teachers are encouraged to shift away from traditional error-focused assessments toward those that celebrate progress and build learner confidence. This pedagogical shift is essential in transforming learners' attitudes toward mathematics and ensuring their willingness to engage in future learning.

Theme 3. Engaging Instruction

Learners described the COM-ADS activities as enjoyable and motivating, indicating that "the activities were fun and made learning math enjoyable." This theme highlights the critical role of engagement in enhancing the teaching and learning process. Learner enjoyment is not trivial—it is a gateway to deeper cognitive processing and sustained attention. McKnight et al. (2022) assert that academic motivation significantly increases when instruction is designed to be both meaningful and engaging. The interactive nature of COM-ADS, which involves games and problem-solving tasks, supports differentiated instruction, as proposed by Tomlinson (2017). In classroom practice, such approaches can lead to improved learner attitudes, better task persistence, and more dynamic participation. For teachers under DepEd, especially those dealing with diverse learner needs in elementary classrooms, the program offers a concrete model of how to balance content mastery with student enjoyment. It encourages educators to explore playful learning without compromising rigor, and to view engagement not as a luxury but as an instructional necessity. By integrating COM-ADS strategies into lesson planning, teachers can meet curriculum objectives while simultaneously cultivating learner interest and enthusiasm for mathematics.

Theme 4. Sustained Learning

A notable observation expressed by learners is the ongoing application of COM-ADS strategies following the conclusion of the intervention: "Even after the program, I continue to utilize the strategies I acquired." This theme highlights the lasting impact and adaptability of skills gained from the program. It aligns with Black and Wiliam's (2009) discoveries that formative practices—when integrated into standard classroom activities—promote self-regulation and autonomous learning. From an educational standpoint, COM-ADS offers students cognitive tools that they can utilize independently, even in unfamiliar problem-solving situations. This is especially crucial in elementary environments where transferring skills may be difficult. As per Vygotsky (1978), students gain the most when supported within their zone of proximal development and slowly allowed to use skills on their own. For DepEd educators, this underscores the importance of concentrating not just on immediate remedial actions but on long-lasting teaching methods that create enduring cognitive effects. Incorporating COM-ADS principles into daily teaching and strengthening them with regular reviews and peer teamwork can promote sustained learning improvements. Additionally, as stated by Lopez and Javellana (2021), reflective action research enables teachers to assess and modify interventions such as COM-ADS, enhancing their effectiveness over time.

4. Conclusion

The research demonstrated that the COM-ADS (Column Adding and Subtracting) technique was an effective approach for improving the numeracy abilities of Grade 2 students. According to statistical analysis, the application of the paired t-test showed a notable enhancement in students' posttest results, suggesting that the structured, game-oriented teaching method led to improved mathematical performance. The intervention enabled students to excel in essential math skills like place value, regrouping, and borrowing, which are crucial for deeper mathematical comprehension. This reinforces the claim that early numeracy teaching must be deliberate, structured, and captivating to achieve noticeable learning improvements, particularly for students identified as low achievers. Additionally, qualitative insights derived from students' views enriched the quantitative outcomes.

Thematic analysis revealed enhanced math abilities, greater student confidence, more interactive classroom experiences, and continued use of acquired strategies after the intervention ended. These findings confirm the capability of the COM-ADS approach to address both educational and emotional learning objectives. It not only promoted computational fluency but also fostered positive attitudes towards math learning-an important element in developing lasting academic motivation. For educators, especially those in the Department of Education (DepEd), the results highlight the significance of using research-based methods that cater to various learning needs through differentiated, learner-focused teaching. The COM-ADS approach demonstrated cost-efficiency, simplicity in implementation, and flexibility across different classroom environments, positioning it as an effective strategy for public elementary schools. Educators are urged to implement these methods not only for remediation but also as integral elements of their fundamental teaching strategies. The research emphasizes the essential role of teacher-researchers in consistently developing and assessing classroom methods through action research. This ongoing cycle of reflection, execution, and assessment is crucial for maintaining effective teaching strategies that address genuine student needs .

REFERENCES

1. Bayaga, A., Bossé, M. J., Fountain, C., & Sevier, J. (2021). From receiving mathematics to negotiating meaning: Development of students' understanding of geometric concepts. *International Journal for Mathematics Teaching and Learning, 22*(2), 1–16. https://www.cimt.org.uk/ijmtl/index.php/IJMTL/article/view/1
2. Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. *Educational Assessment, Evaluation and Accountability, 21*(1), 5–31. https://doi.org/10.1007/s11092-008-9068-5
3. Bryant, D. P., Bryant, B. R., & Smith, D. D. (2015). *Teaching mathematics to students with learning disabilities*. Guilford Publications.
4. Bryant, D. P., Bryant, B. R., Gersten, R., Scammacca, N., Funk, C., Winter, A., & Pool, C. (2011). The effects of tier 2 intervention on the mathematics performance of first-grade students who are at risk for mathematics difficulties. *Exceptional Children, 77*(2), 265–280. https://doi.org/10.1177/001440291107700208
5. Clements, D. H., & Sarama, J. (2021). *Learning and teaching early math: The learning trajectories approach* (3rd ed.). Routledge. https://www.researchgate.net/publication/358908575
6. Dela Cruz, J. M., Reyes, L. D., & Santos, M. T. (2019). Statistical methods for educational research: Application and interpretation in Philippine schools. *Philippine Journal of Educational Measurement*, 6(1), 25–40.
7. Deci, E. L., & Ryan, R. M. (2022). *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press.
8. Department of Education. (2016). *DepEd Order No. 35, s. 2016: The learning action cell as a K to 12 basic education program school-based continuing professional development strategy for the improvement of teaching and learning*. Department of Education Philippines.
9. Department of Education. (2019). *DepEd Order No. 34, s. 2019 – Revised Physical Fitness Test Manual*. https://www.deped.gov.ph/wp-content/uploads/2019/12/DO_s2019_034.pdf
10. Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random House.
11. Fuchs, L. S., & Fuchs, D. (2001). The role of intervention in mathematics education. *Journal of Educational Psychology, 93*(2), 226–234. https://doi.org/10.1037/0022-0663.93.2.226
12. Houeiry, G. (2021, September 14). One-group pretest-posttest design: An introduction. *Quantifying Health*. https://quantifyinghealth.com/one-group-pretest-posttest-design/
13. JMP. (n.d.). Paired t-test | Introduction to statistics. https://www.jmp.com/en/statistics-knowledge-portal/t-test/paired-t-test.html
14. Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it up: Helping children learn mathematics*. National Academy Press.

15. Liggett, R. (2017). The impact of use of manipulatives on the math scores of grade 2 students. *Brock Education Journal*, *26*(2), 87–101. https://files.eric.ed.gov/fulltext/EJ1160704.pdf

16. Lopez, R., & Javellana, E. (2021). Action research as a tool for reflective practice: Empowering teachers in DepEd. *Southeast Asian Journal of Educational Studies, 12*(2), 102–116.

17. McKnight, K. S., McKnight, P. E., & McKnight, K. M. (2022). Academic interventions and learner motivation: The impact of effective teaching. *Journal of Educational Research*, *115*(3), 134–149. https://doi.org/10.1080/00220671.2021.1882047

18. Mullis, I. V. S., Martin, M. O., & Loveless, T. (Eds.). (2020). *TIMSS 2019 encyclopedia: Education policy and curriculum in mathematics and science – Philippines*. TIMSS & PIRLS International Study Center, Boston College. https://timssandpirls.bc.edu/timss2019/encyclopedia/philippines.html

19. Nelson, G., & McMaster, K. (2019). Factors that may influence treatment effects: Helping practitioners interpret the results of early numeracy intervention research. *Learning Disabilities Research & Practice*, *34*(2), 81–89. https://doi.org/10.1111/ldrp.12195

20. Organisation for Economic Co-operation and Development. (2023). *PISA 2022 results (Volume I and II) – Country Notes: Philippines*. https://www.oecd.org/en/publications/pisa-2022-results-volume-i-and-ii-country-notes_ed6fbcc5-en/philippines_a0882a2d-en.html

21. Sage Research Methods. (n.d.). One-group pretest–posttest design. In *The SAGE Encyclopedia of Communication Research Methods*. https://methods.sagepub.com/ency/edvol/the-sage-encyclopedia-of-communication-research-methods/chpt/onegroup-pretest-posttest-design

22. Schneider, L., & Siegler, R. S. (2022). Counting and the ontogenetic origins of exact equality. *Cognitive Psychology*, *132*, 101423. https://doi.org/10.1016/j.cogpsych.2021.101423

23. Tan, M. J., & Javier, M. A. (2022). Family and individual variables associated with young Filipino children's numeracy interest and competence. *Early Child Development and Care, 192*(4), 607–620. https://doi.org/10.1080/03004430.2020.1824912

24. Tomlinson, C. A. (2017). *How to differentiate instruction in academically diverse classrooms* (3rd ed.). ASCD.

25. Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.