

**The efficacy of Contextualized Active and Collaborative Engagement (CACE)  
Manipulatives in learning data and probability for Grade 2 Mathematics**

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**ABSTRACT**

This study investigated the effectiveness of Contextualized Active and Collaborative Engagement (CACE) manipulatives in improving the mathematics performance of Grade 2 learners at Bonifacio Central Elementary School during School Year 2025–2026. The study focused on the least learned competency in Mathematics 2, Third Quarter, which was identified through a diagnostic test. A descriptive-developmental research design was employed, guided by the ADDIE model in the design, development, implementation, and evaluation of the CACE manipulatives. The manipulatives were validated by four master teachers and one school principal using the DepEd Learning Resources Management and Development System (LRMDS) rating sheet to ensure content accuracy, instructional effectiveness, and technical quality. Learners' performance was measured using a pretest and posttest, and the data were analyzed using mean performance scores (MPS), standard deviation, and a paired samples t-test. Results showed that learners' pretest performance was at a very low proficiency level. After exposure to the CACE manipulatives, learners demonstrated a significant improvement, with most reaching the highly proficient level in the posttest. The paired samples t-test revealed a statistically significant difference between pretest and posttest scores, confirming the effectiveness of the intervention. Expert evaluations rated the manipulatives as very satisfactory in terms of content, instructional design, technical design, and other quality indicators, with no errors identified. Classroom observations also revealed increased learner interest, participation, collaboration, and confidence during mathematics lessons. The study concludes that CACE manipulatives are effective instructional tools in improving learners' mathematics performance and engagement. It is recommended that training be conducted through LAC sessions for Grade 1–3 teachers of Bonifacio Central Elementary School on developing and using CACE-type instructional materials be integrated into mathematics instruction, particularly for the least learned competencies, and be considered for submission to the DepEd LRMDS for wider classroom use.

**Keywords:** Contextualized Active Collaborative Engagement CACE Manipulatives, Mathematics performance, Grade 2 learners, least learned competency

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## INTRODUCTION

Data and Probability are crucial parts of early-grade mathematics. They help young learners build skills in collecting, organizing, analysing, and interpreting information from daily life. Simple activities like identifying preferences, observing routines, and recognizing patterns allow learners to see how data connects to real situations. Using basic tools such as tally charts, pictographs, and bar graphs makes abstract ideas clearer. This approach supports the development of logical reasoning, critical thinking, and informed decision-making (Ow Yeong et al., 2023).

Around the world, statistical literacy and reasoning about chance are important skills for learners in the 21st century. Countries like Singapore, Finland, and Australia include Data and Probability in their primary math curricula through inquiry-based and hands-on methods. These techniques prompt learners to explore data, make predictions, analyze results, and share findings in meaningful ways. This strengthens both their mathematical understanding and communication skills (Vásquez & Alsina, 2021). International frameworks, such as the OECD Learning Compass 2030 and UNESCO reports, stress that abstract concepts are best learned through concrete and meaningful experiences.

In Southeast Asia, regional programs led by SEAMEO promote early statistical and probabilistic thinking through interactive and contextual teaching methods. Research in the region shows that learners grasp mathematical concepts better when lessons relate to their everyday lives and when they work actively with their peers instead of passively taking in information (Tan & Lim, 2023). These findings match global evidence that active and cooperative learning improves understanding, retention, and motivation.

In the Philippines, the MATATAG Curriculum emphasizes mastering basic skills, practical application, and contextual learning in early-grade math (DepEd, 2024). Local studies show that hands-on and relevant activities boost learner engagement and understanding (Bautista & Dela Cruz, 2023). However, national and international assessments, including PISA 2022 and SEA-PLM 2021, reveal that many Filipino students continue to struggle with interpreting data, creating visual representations, and understanding basic probability concepts.

This points to ongoing challenges in turning curriculum goals into effective teaching practices. Even with efforts like the Early Language, Literacy, and Numeracy (ELLN) Program and the promotion of learner-centered methods, many classrooms still depend on traditional teaching techniques such as lectures and worksheets, especially for abstract topics like Data and Probability (Francisco & de Guzman, 2022). This often restricts student engagement and impedes a deeper understanding of the concepts.

Bonifacio Central Elementary School faced similar issues among Grade 2 learners. Assessment results and classroom observations showed challenges in interpreting pictographs, reading tally charts, and grasping basic probability concepts. Data and Probability had the lowest Mean Percentage Scores among the math domains, highlighting the need for more engaging and fitting teaching strategies.

This study is based on Experiential Learning Theory of John Dewey and Jerome Bruner's Theory of Modes of Representation. These theories stress that meaningful learning happens through active engagement and concrete experiences. Experiential learning asserts that learners build knowledge by doing, reflecting, and applying learning in real situations. Bruner's framework explains that learning moves through enactive, iconic, and symbolic modes, helping learners transition from hands-on manipulation to visual representation and finally to abstract mathematical symbols (Bruner, 1966).

Despite the importance of hands-on learning, many Grade 2 learners struggle to grasp abstract concepts in Data and Probability due to limited access to contextualized and engaging instructional materials. This study aims to design, develop, and evaluate Contextualized Active and Collaborative Engagement (CACE) manipulatives to support meaningful learning and improve mathematics performance.

By providing opportunities for active participation, collaboration, and concrete representation of data, the CACE manipulatives are expected to enhance learners' understanding, engagement, and confidence, offering teachers a practical tool to make early mathematics instruction more effective and learner-centered.

### Statement of the problem

This study aimed to determine the effectiveness of Contextualized Active and Collaborative Engagement (CACE) manipulatives in teaching Data and Probability to Grade 2 learners at Bonifacio Central Elementary School. Specifically, it seeks to answer the following questions:

1. How may CACE manipulatives be designed and developed?
2. What is the level of performance of the learners before and after the utilization of contextualized CACE manipulatives?
3. How do experts evaluate the Contextualized Active and Collaborative Engagement (CACE) manipulatives in terms of content, other findings, and additional requirements for the manipulative?
4. Is there a significant difference in the learners' performance before and after using the CACE manipulatives?
5. Based on the findings, how may the contextualized CACE manipulatives be enhanced?

### METHODOLOGY

This chapter presents the research design, research locale, population and participants of the study, sampling design, research instrument, validation and reliability of the research, data gathering procedures, scoring and quantification of data, performance and evaluation scales, and statistical treatment employed in determining the effectiveness of Contextualized Active and Collaborative Engagement (CACE) manipulatives in teaching Data and Probability to Grade 2 learners. The study employed a descriptive developmental research design guided by the ADDIE instructional model, which consists of the phases Analysis, Design, Development, Implementation, and Evaluation. This design was appropriate because the study focused on developing, validating, and describing the effectiveness of Contextualized Active and Collaborative Engagement (CACE) manipulatives in teaching Data and Probability to Grade 2 learners at Bonifacio Central Elementary School.

The study was conducted at Bonifacio Central Elementary School located in Barangay Bayugan 3, Rosario, Agusan del Sur, under Rosario District II. The school is situated along the national highway approximately 15 kilometers from the town proper and is classified as a rural school. During School Year 2025 to 2026, the school had an enrolment of approximately 1,600 learners and a teaching force of 57 teachers, including four master teachers, two Alternative Learning System teachers, two non-teaching personnel, and one school principal. The school is categorized as a large school and holds a Level II School Based Management rating, indicating effective leadership, collaboration, and commitment to continuous improvement. Most learners reside within the surrounding puroks of Barangay Bayugan 3, fostering a close and supportive school community. The school actively upholds the Department of Education

goal of providing quality, inclusive, and learner centered education and is open to innovative, research based instructional practices. Given its accessible location, supportive learning environment, and readiness to adopt instructional innovations, Bonifacio Central Elementary School provided an appropriate setting for the implementation and evaluation of Contextualized Active and Collaborative Engagement CACE manipulatives aimed at improving Grade 2 learners understanding of Data and Probability.

The study involved thirty-four (34) Grade 2 learners from Section Polite of Bonifacio Central Elementary School, Rosario District II, during School Year 2025 to 2026. The participants consisted of twelve (12) boys and twenty-two (22) girls aged 7 to 9 years. These learners were the advisees of the researcher and were selected as an intact group to maintain the natural classroom setting and ensure that teaching and learning occurred in a familiar and comfortable environment. Most of the learners reside in Barangay Bayugan 3 near the school and come from varied family backgrounds while sharing similar learning characteristics common among pupils in rural communities. Using an intact group allowed the implementation of Contextualized Active and Collaborative Engagement CACE manipulatives within regular classroom instruction, making the learning experience authentic, relevant, and meaningful. This group was appropriate for the study as Grade 2 learners benefit from hands on, interactive, and collaborative learning activities, especially in understanding abstract concepts in Data and Probability. The distribution of the participants showed that 12 were male representing 35% and 22 were female representing 65%, for a total of 34 learners comprising 100% of the study population.

The study employed complete enumeration, which included all Grade 2 learners from Section Polite of Bonifacio Central Elementary School during School Year 2025 to 2026. The respondents consisted of both male and female learners aged 7 to 9 years. An intact group technique was used for accessibility and practicality since Section Polite was the class handled by the researcher as the adviser, making it readily available and suitable for implementing the contextualized Active and Collaborative Engagement CACE manipulatives in lessons on Data and Probability. Using the entire class helped maintain a natural and undisturbed classroom environment, allowing the researcher to observe authentic teaching learning interactions. Since the study followed a quantitative research design, data were collected from the whole class to generate results that are measurable, comparable, and statistically analyzable. This sampling approach strengthened the reliability of the findings and provided a clear picture of how the CACE manipulatives influenced learners' mathematics performance.

The Department of Education diagnostic test served as the main research instrument to measure the effectiveness of the Contextualized Active and Collaborative Engagement CACE manipulatives in teaching Data and Probability to Grade 2 learners. The instrument consisted of a pretest and a posttest to assess learners' performance before and after the intervention, as well as expert validation tools to evaluate the developed instructional materials. The pretest and posttest assessments were aligned with the Grade 2 Mathematics curriculum and covered pictographs, tally charts, and basic probability. Each test consisted of ten (10) multiple choice items designed to measure learners understanding and application of Data and Probability concepts. Learners' improvement was determined by comparing their pretest and post test results. To ensure the quality and suitability of the instructional materials, content validation was conducted by a panel of experts composed of four (4) master teachers and the school principal. The LRMSD Evaluation Rating Sheet was used to assess the materials in terms of content, Other Findings and Additional requirements for Manipulative. Suggestions from the validators were incorporated to improve the materials before classroom use.

To ensure validity and reliability, the pretest and post test instruments as well as the evaluation tools for the Contextualized Active and Collaborative Engagement CACE

manipulatives were carefully reviewed by a panel consisting of four Master Teachers and the School Principal of Bonifacio Central Elementary School under the Division of Agusan del Sur. The experts evaluated the tools for clarity, alignment with Grade 2 learning competencies, and suitability for measuring learners' performance. Feedback from the panel was incorporated to improve the instruments effectiveness and accuracy. After revisions, the final instruments were submitted to the Thesis Evaluation Committee of Agusan Colleges Incorporated for review and approval.

Data collection was conducted systematically and ethically to ensure accurate and reliable results. Prior to the conduct of the study, the researcher secured written permission from the school principal and coordinated with parents to explain the purpose, procedures, and schedule of the research. A pretest was administered to Grade 2 Section Polite to determine learners initial understanding of Data and Probability, and the results served as baseline data. The Contextualized Active and Collaborative Engagement CACE manipulatives were then implemented during regular mathematics lessons through hands on and collaborative activities. After the intervention, a post test was administered to the same group of learners. The pretest and post test results were compared to measure learning gains and determine the effectiveness of the CACE manipulatives. Ethical standards were strictly observed throughout the process. Participation was voluntary, parental consent was obtained, and all data were kept confidential to protect learners' identities.

A 10-item diagnostic test was administered before and after the instructional intervention to assess learners understanding of Data and Probability. The pretest identified learners' prior knowledge and areas of difficulty particularly in pictographs, tally charts, and basic probability, while the posttest measured learning gains and the effectiveness of the CACE manipulatives in helping learners grasp these concepts. Each test item was age appropriate, clear, and aligned with the Grade 2 Mathematics curriculum, and scoring was done using a consistent scale to ensure fairness and objectivity. During the intervention, learners engaged in hands on, collaborative activities that encouraged discussion, problem solving, and critical thinking. Comparing pretest and post test results allowed the researcher to determine improvements in understanding and highlighted the value of contextualized, interactive, and cooperative learning experiences in making mathematics engaging and meaningful.

Learners' performance was interpreted using a mastery scale based on raw scores and corresponding percentages. A raw score of 9 to 10 corresponding to 90 to 100% was described as Highly Proficient, indicating that learners have a strong grasp of the concepts and can apply them accurately with little to no mistakes. A raw score of 8 corresponding to 75 to 89% was described as Proficient, showing good understanding and performance with minor errors. Scores ranging from 5 to 7 corresponding to 50 to 74% were described as Nearly Proficient, indicating partial understanding and the need for additional practice and guidance. A raw score of 3 to 4 corresponding to 25 to 49% was described as Low Proficient, meaning learners struggle with key concepts and require more support. Scores ranging from 0 to 2 corresponding to 0 to 24% were described as Not Proficient, indicating difficulty in understanding the topic and the need for thorough review and assistance to build foundational skills.

The evaluation of the CACE manipulatives by experts was interpreted using a rating scale with corresponding numerical ranges and descriptions. A rating of 4 with a mean range of 3.26 to 4.00 was described as Very Satisfactory VS, indicating that the manipulatives are well designed, easy to use, and highly effective for teaching. A rating of 3 with a mean range of 2.51 to 3.25 was described as Satisfactory or Needs Adjustment S or NA, suggesting that while the manipulatives function well, minor improvements could enhance their effectiveness. A rating of 2 with a mean range of 1.76 to 2.50 was described as Poor P, indicating notable limitations that affect usefulness. A rating of 1 with a mean range of 1.00 to 1.75 was described

as Not Satisfactory NS, signifying that the manipulatives fall short of expectations and require major revisions to be effective in learning.

The data were analyzed using both descriptive and inferential statistics to determine the effectiveness of the Contextualized Active and Collaborative Engagement CACE manipulatives in teaching Data and Probability to Grade 2 learners. Frequency and Percentage were used to show how learners were distributed across mastery levels in the pretest and posttest, indicating how many were Highly Proficient, Proficient, Nearly Proficient, Low Proficient, or Not Mastered. Mean and Standard Deviation were computed, with the mean representing the learner's average performance and the standard deviation assessing the consistency of scores and highlighting patterns in mastery levels. Weighted Mean was used to summarize expert evaluations of the CACE manipulatives using the LRMSDS rating sheet, reflecting overall quality and identifying areas for improvement. A Paired Sample t Test was employed to compare pretest and post test scores and determine whether the CACE manipulatives led to a statistically significant improvement in learners understanding of Data and Probability at a 0.05 significance level.

## RESULTS AND DISCUSSION

This chapter presents and analyzes the data gathered from thirty-four (34) Grade 2 learners from Section Polite of Bonifacio Central Elementary School during School Year 2025 to 2026 in order to determine the effectiveness of the Contextualized Active and Collaborative Engagement (CACE) manipulatives in improving performance in Data and Probability. Guided by a descriptive developmental research design anchored on the ADDIE model, the study utilized complete enumeration of an intact class and employed a 10 item Department of Education diagnostic test administered as pretest and posttest. Expert validation was conducted using the DepEd LRMSDS rating sheet, and the data were analyzed through Frequency, Percentage, Mean, Standard Deviation, Weighted Mean, and Paired Sample t Test at a 0.05 level of significance. The discussion that follows is grounded strictly in the empirical data gathered and interpreted directly in relation to the objectives of the study, particularly the design and development of the CACE manipulatives, learners' level of performance before and after exposure, expert evaluation of the materials, and the determination of statistically significant improvement.

The design and development of the CACE manipulatives were informed by areas where learners previously demonstrated low mastery in Data and Probability. The materials were contextualized, collaborative, and aligned with specific Grade 2 learning competencies. Four master teachers and the school principal evaluated the manipulatives using the DepEd LRMSDS rating sheet. Expert feedback emphasized clarity of labels, organized layout, age-appropriate design, and flexibility for adaptation across lessons and skill levels. These qualitative validations were subsequently supported by quantitative evaluation results.

Learners' level of performance before and after exposure to the CACE manipulatives revealed a marked shift in mastery distribution. Before the intervention, 23 learners representing 67.6% were at the 25% to 49% range classified as Low Proficiency, and 11 learners representing 32.4% were at the 0% to 24% range classified as Not Proficient. No learners reached the 50% to 74% Nearly Proficient range, the 75% to 89% Proficient range, or the 90% to 100% Highly Proficient range. After the intervention, the distribution changed substantially. Twenty-seven learners representing 79.4% achieved the 90% to 100% range classified as Highly Proficient, 6 learners representing 17.6% reached the 75% to 89% range classified as Proficient, and 1 learner representing 2.9% attained the 50% to 74% range classified as Nearly Proficient. No learners remained in the Low Proficiency or Not Proficient

categories. The total number of learners remained 34 representing 100% both before and after the intervention. This complete upward shift from 67.6% Low Proficiency and 32.4% Not Proficient to 79.4% Highly Proficient and 17.6% Proficient provides strong descriptive evidence that exposure to the CACE manipulatives corresponded with substantial gains in mastery of Data and Probability.

The expert evaluation of the CACE manipulatives in terms of content further substantiated the quality of the materials. Across ten indicators, including reinforcement and mastery of competencies, potential to arouse interest, accuracy of facts, updated information, relevance and clarity of visuals, suitability to age level, typographic layout, appropriate size, and durability and ease of use, each indicator received a Weighted Mean of 4.00 with a verbal description of Very satisfactory and an interpretation of Very suitable. The Overall Weighted Mean was likewise 4.00, interpreted as Very satisfactory and very suitable based on the legend 3.50 to 4.00 Very Satisfactory or Very suitable. These uniform ratings of 4.00 indicate complete agreement among evaluators regarding the instructional soundness and learner appropriateness of the materials.

In terms of other findings, all four indicators namely conceptual errors, factual errors, grammatical and or typographical errors, and other errors including computational errors or obsolete information each received a Weighted Mean of 4.00 with the verbal description Not present. According to the legend 3.50 to 4.00 Not present, this confirms that no conceptual, factual, grammatical, computational, or visual errors were detected. Such results demonstrate technical accuracy and reliability, ensuring that learners engage with mathematically sound content and that teachers can implement the materials with confidence.

The evaluation of instructional design and technical design yielded similarly consistent results. Under instructional design, three indicators including reinforcement of competencies, potential to arouse interest, and factual accuracy each received a Weighted Mean of 4.00 with a verbal description of Very satisfactory and an interpretation of Very suitable. Under technical design, indicators including updated information, relevance of visuals, and suitability of visuals to age level each also received a Weighted Mean of 4.00 with the same verbal description and interpretation. Based on the legend 3.50 to 4.00 Very Satisfactory or Very suitable, these results confirm that both pedagogical structure and technical presentation meet the highest evaluation standard. The convergence of these perfect ratings across content, absence of errors, instructional design, and technical design supports the conclusion that the CACE manipulatives are classroom ready and aligned with quality standards set by DepEd (2021).

The inferential analysis through Paired Sample t Test provided statistical confirmation of the descriptive trends. The mean pretest score was 2.76 with  $SD=1.075$ , placing learners at the very low proficiency level and indicating substantial variability below the mean prior to intervention. In contrast, the mean posttest score increased to 9.53 with  $SD=.896$ , reflecting convergence of scores above the mean and aligning with the Highly Proficient category. The computed t value was 32.007 with  $p=.000$ , and this result was marked significant @  $p<.01$ . Since  $p=.000$  is less than the 0.05 level of significance, the null hypothesis was rejected. The statistical decision Reject  $H_0$  and the interpretation Significant confirm that there was a statistically significant difference between pretest and posttest scores. The magnitude of the t value 32.007 indicates a very strong effect of the intervention on learner performance in Data and Probability. These results empirically demonstrate that the CACE manipulatives were effective in helping learners master competencies such as presenting raw data in tabular form or pictograph with scale and interpreting data in tabular form and in a pictograph with or without scale.

Beyond numerical gains, classroom observations indicated heightened enthusiasm, increased participation, and collaborative interaction among learners during the use of the

manipulatives. These behavioral patterns align with experiential learning theory as articulated by Dewey (1938), who posited that knowledge develops through direct interaction and reflective experience. The learners' engagement in handling materials and discussing solutions reflects active construction of meaning. Bruner's (1973) Modes of Representation further contextualize the progression observed in the data. Learners moved from enactive manipulation of concrete materials to iconic representation through charts and pictographs, and ultimately to symbolic reasoning using mathematical language and numerical interpretation. The significant increase from  $M=2.76$  to  $M=9.53$  and the elimination of 67.6% Low Proficiency and 32.4% Not Proficient categories after the intervention illustrate this transition from concrete exploration to abstract mastery.

In light of the consistently high expert ratings and statistically significant performance gains, the proposed improvements for effective use of the CACE manipulatives focus not on correcting deficiencies but on enhancing sustainability and scalability. Although all evaluative indicators received 4.00, suggestions included adding more real-life examples, enhancing visual clarity, integrating collaborative features, providing scaffolding tips for teachers, and improving durability and portability. These refinements aim to strengthen already validated materials and ensure broader adaptability. The recommendation to conduct LAC sessions for Grade 1 to 3 teachers at Bonifacio Central Elementary School supports capacity building and consistent implementation. Submission of the enhanced manipulatives to the Agusan del Sur DepEd LRMS for official validation is likewise recommended to promote wider adoption and institutional quality assurance.

In synthesis, the findings demonstrate that among 34 Grade 2 learners, exposure to the Contextualized Active and Collaborative Engagement manipulatives resulted in a complete redistribution of mastery levels from 67.6% Low Proficiency and 32.4% Not Proficient to 79.4% Highly Proficient, 17.6% Proficient, and 2.9% Nearly Proficient, with a statistically significant difference confirmed by  $t=32.007$  and  $p=.000$  at the 0.05 level of significance leading to the rejection of the null hypothesis. Expert evaluations uniformly yielded Weighted Means of 4.00 across all indicators of content, absence of errors, instructional design, and technical design, interpreted as Very satisfactory and very suitable. Collectively, these results address the research objectives by confirming the successful design, validation, and effectiveness of the CACE manipulatives in improving understanding of Data and Probability. The findings contribute to the growing body of evidence supporting contextualized, collaborative, and hands-on approaches in early mathematics instruction and provide a validated model for instructional innovation in rural elementary settings, thereby preparing the foundation for the subsequent chapter on conclusions and recommendations.

## CONCLUSION

This chapter synthesizes the major findings of the investigation on the effectiveness of Contextualized Active and Collaborative Engagement (CACE) manipulatives in improving the mathematics performance of Grade 2 learners in Data and Probability. The study examined how the manipulatives were designed, evaluated, and implemented, and how their use influenced learner mastery and engagement. Drawing from the descriptive and inferential results presented in the preceding chapter, this conclusion integrates the empirical evidence and interpretive insights into a unified reflection on the instructional value, quality, and sustainability of the CACE approach.

The findings demonstrate that the CACE manipulatives were carefully designed using learners' least mastered competencies as the foundation for development, ensuring alignment with curriculum standards and responsiveness to identified learning gaps. The materials

underwent expert validation using DepEd LRMDs standards and were rated Very Satisfactory across all evaluated dimensions, confirming their accuracy, clarity, instructional soundness, and technical quality. The absence of conceptual, factual, grammatical, and visual errors further affirms that the manipulatives met established quality benchmarks for classroom implementation. These results support the conclusion that contextualized and data driven instructional design contributes significantly to the development of effective and learner appropriate mathematics materials.

The study also established that prior to the intervention, learners exhibited low mastery of Data and Probability concepts, with the majority categorized under Low Proficient and Not Proficient levels. This baseline performance underscored the need for improved instructional strategies and more engaging learning tools. Following the implementation of the CACE manipulatives, learner performance improved significantly, as confirmed by the paired samples t test, which indicated a statistically significant difference between pretest and posttest results. This empirical evidence confirms that the CACE manipulatives were effective in enhancing learners' understanding, confidence, and performance in mathematics. The findings further suggest that contextualized, hands on, and collaborative learning experiences play a crucial role in helping young learners grasp abstract mathematical concepts.

From these results, it can be concluded that Contextualized CACE manipulatives may be effectively designed when grounded in learners' needs and aligned with curriculum standards. The study also affirms that without appropriate and engaging instructional materials, learners may struggle to master essential mathematical competencies. Expert validated materials not only ensure accuracy and relevance but also support effective and confident classroom implementation. Moreover, the use of CACE manipulatives may significantly improve both learners' mathematics performance and their active engagement in the learning process. At the same time, the findings highlight that continuous refinement and teacher capacity building are necessary to sustain and maximize the long-term impact of such instructional innovations.

In light of these conclusions, it is recommended that teachers consider designing instructional materials based on learners' least mastered competencies using the CACE approach as a guiding framework. Schools are likewise encouraged to integrate hands on and collaborative strategies to address persistent low performance in mathematics. Instructional materials should undergo expert validation using DepEd LRMDs standards prior to classroom implementation to ensure quality and alignment with competencies. Regular use of contextualized manipulatives is advised to strengthen learners' conceptual understanding and confidence in mathematics. Furthermore, training sessions may be conducted for Grade 1 to 3 teachers of Bonifacio Central Elementary School to support the development and effective use of CACE type instructional materials. The validated manipulatives may also be submitted to the DepEd LRMDs to promote wider adoption and ensure sustained quality assurance across the division.

Overall, the study confirms that the Contextualized Active and Collaborative Engagement manipulatives constitute a pedagogically sound, empirically supported, and context responsive instructional intervention. By integrating learner centered design, expert validation, and collaborative classroom practices, the CACE approach offers a practical and sustainable model for improving mathematics instruction in the early grades.

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