

Original Article

Concrete-Pictorial-Abstract (CPA) and Traditional Methods of Instruction in Enhancing Mathematical Proficiency Among Grade 7 Learners

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Abstract. The desire to enhance students' mathematical proficiency has encouraged many teachers to adopt innovative teaching approaches, such as the Concrete-Pictorial-Abstract (CPA) method, and to provide alternatives to traditional instructional methods. This study aimed to determine which method is more effective in improving students' mathematical proficiency. A quasi-experimental research design was used, specifically a pretest-posttest design, and data were analyzed using an independent-samples t-test. Using purposive and universal sampling techniques, a total of 100 students from the Department of Education, Division of Davao City, served as respondents in the study. Data were gathered through a researcher-made mathematical proficiency test, which underwent content validation and reliability testing. The results revealed that students taught using the Concrete-Pictorial-Abstract (CPA) method obtained higher mathematical proficiency scores ($M = 55.78$) than those taught using the traditional method ($M = 47.84$), and the independent samples t-test showed a statistically significant difference between the two groups ($t = 2.88$, $p = .005$). The study concluded that while both the CPA method and the traditional method improved Grade 7 students' mathematical proficiency, the CPA method produced significantly greater learning gains and was more effective in enhancing students' conceptual understanding, problem-solving skills, and overall mathematical performance.

Keywords: Concrete-Pictorial-Abstract (CPA) Method; Mathematical proficiency; Traditional teaching method; Conceptual understanding; Problem-solving skills.

The continuous effort to improve students' mathematical proficiency has encouraged educators to adopt innovative teaching approaches and explore alternatives to traditional instruction. Despite long-standing use of traditional teaching methods, concerns remain regarding their effectiveness in developing learners' conceptual understanding and problem-solving skills in mathematics. This issue has become more evident as students continue to struggle to understand abstract mathematical concepts. In response, teachers have explored structured approaches such as the Concrete-Pictorial-Abstract (CPA) method, which supports learning by guiding students from concrete experiences to visual representations and, finally, to abstract symbols. According to Prosser and Bismarck (2023), the CPA method, also known as the Concrete-Representational-Abstract (CRA) approach in some contexts, provides a step-by-step process that helps learners build a strong mathematical understanding.

Globally, studies have shown mixed but generally positive results regarding the effectiveness of CPA and similar approaches compared to traditional instruction. Akinoso (2015) found that the CRA method was more effective than traditional methods in improving students' performance. Similarly, Ouyang (2023) reported that CPA-related instruction improved students' mathematics test scores compared to traditional teaching. In Spain, Canto López et al. (2022) found that students taught using CPA-based methods performed better in various mathematical skills than those in traditional classrooms. Robert (2020) also observed that CPA improves students' proactive learning in mathematics by connecting concrete and abstract ideas. Mizzi and Calleja (2024) concluded that CPA enhances students' understanding through scaffolded learning, although some learners still need support when shifting to abstract reasoning. This finding indicates that CPA does not automatically guarantee success for all learners. While the approach provides structured support, some students still struggle to progress from concrete and pictorial representations to abstract mathematical thinking. These challenges may stem from differences in cognitive readiness, prior mathematical knowledge, learning pace, and individual learning needs. These findings suggest that CPA and similar approaches may offer advantages over traditional instruction in improving mathematical learning outcomes. However, variability in learners' responses suggests that CPA's effectiveness may depend not only on the instructional approach but also on learner-related factors that affect the transition to abstract reasoning.

In Asia, several studies further support CPA's effectiveness. Nugroho and Jailani (2019) found that Indonesian students taught using CRA, like CPA, demonstrated better mathematical representation skills than those taught through traditional methods. In Bhutan, Tenzin (2024) reported that traditional instruction often limits students' ability to connect abstract concepts to real-life situations, while CPA improves conceptual understanding. Shafiee and Meng (2023) found that integrating CPA with Collaborative Lesson Research improved students' understanding of volume in geometry. Leong et al. (2015) emphasized that proper CPA implementation in Singapore is important for addressing challenges in traditional mathematics teaching. Ahmad and Siller (2024) also found that using concrete and virtual manipulatives in CPA instruction improved students' mathematics achievement compared to traditional instruction. Although these studies reported positive outcomes, they also suggest that effective implementation plays a crucial role in CPA success. Leong et al. (2015) emphasize proper implementation, suggesting that teacher expertise, instructional planning, and classroom facilitation may influence how effectively learners engage with CPA activities. Likewise, access to appropriate manipulatives and learning resources may affect the quality of students' learning experiences. Therefore, differences in teacher preparation and resource availability may partly explain variations in CPA outcomes across educational settings. These studies consistently show that CPA supports better learning outcomes than traditional approaches in mathematics education.

In the Philippine context, several studies have also reported CPA's effectiveness. Leyson and Andrino (2025) found that CPA improved pupils' mathematics performance compared to traditional methods. Salingay and Tan (2018) reported similar findings, showing higher performance among learners exposed to CPA instruction. Camañan (2019) also found that students taught using CRA, like CPA, performed better than those taught using traditional lecture methods. Binatlao and Cordova (2025) reported that CPA enhances students' problem-solving skills in mathematics. Reyes (2021) also found that CRA-based instruction improved students' learning in probability compared to traditional methods. Toong (2015) further explained that CRA improved conceptual understanding, procedural fluency, and problem-solving skills compared to rote-based instruction. Despite these findings, Filipino learners continue to struggle in mathematics. Ines (2023) reported that the Philippines performed poorly in the Programme for International Student Assessment (PISA 2022), while OECD (2023) confirmed that only a small percentage of learners reached the minimum proficiency level in mathematics. The contrast between the positive findings reported in CPA studies and Filipino learners' persistently low mathematics performance highlights an important gap in the literature. While CPA has demonstrated effectiveness in controlled classroom settings and specific learning contexts, its broader impact may be influenced by systemic challenges such as large class sizes, limited instructional resources, variations in teacher preparedness, and differences in implementation fidelity. These factors may reduce the consistency of CPA outcomes across schools and learning environments. Furthermore, the persistence of low mathematics achievement suggests that no single instructional approach can fully address the complex challenges affecting mathematics education. Thus, further research is needed not only to determine whether CPA is effective but also to examine the conditions under which it produces the greatest benefits for learners.

At the local level, particularly in Davao City, teachers have reported using the CPA method to improve students'

learning in mathematics. Informal observations suggest that CPA may improve engagement and performance; however, empirical evidence supporting these claims remains limited. Angco and Angco (2024) stated that factors such as teacher training, instructional materials, and learners' prior knowledge may affect CPA's effectiveness. Kaur et al. (2022) explained that Grade 7 is a critical stage where students transition to more complex mathematical concepts. Evans et al. (2025) also noted that focusing on a single school allows for better control of instructional conditions and more accurate monitoring of implementation. These considerations highlight the need for a focused investigation in the local setting. Although many studies have shown the effectiveness of CPA and CRA methods across different contexts, limited research has examined their effectiveness under the MATATAG Curriculum in the Philippine setting. Most existing studies were conducted under previous curriculum frameworks, such as the K to 12 system. This creates a research gap in understanding whether CPA remains effective in improving mathematical proficiency under the updated curriculum. Addressing this gap is important as schools continue to adjust instructional practices to meet new curriculum demands. This study's findings may provide useful evidence for teachers, school leaders, and curriculum developers in selecting effective instructional strategies for mathematics education.

Overall, the reviewed literature suggests that CPA generally produces better mathematical outcomes than traditional instruction across different educational contexts. However, the findings also indicate that its effectiveness is not uniform and may depend on learner characteristics, teacher competence, instructional resources, and implementation quality. While previous studies have established the potential benefits of CPA, limited research has examined its effectiveness among Grade 7 learners under the MATATAG Curriculum, thereby justifying the need for the present study.

This study is anchored on Bruner's Theory of Representations (Bruner, 1974) and Vygotsky's Activity Theory (Vygotsky, 1978). Bruner's theory explains that learning progresses through the enactive, iconic, and symbolic stages, which align with the CPA method's progression from concrete materials to pictorial representations and, finally, to abstract symbols. Through this sequence, CPA scaffolds students' transition from hands-on experiences to visual models and ultimately to symbolic mathematical reasoning, enabling them to develop conceptual understanding gradually and meaningfully. Vygotsky's Activity Theory emphasizes that learning occurs through guided activities, interaction, and learning tools within a social context. This perspective supports the interactive nature of CPA, where teacher mediation, collaborative learning, and guided participation help students construct mathematical knowledge and deepen their understanding. Together, these theories support the idea that CPA provides structured and interactive learning experiences that promote deeper understanding. In contrast, traditional instruction often focuses primarily on abstract symbols and uses insufficient concrete and visual supports. Therefore, this study aims to determine the effectiveness of the CPA method compared to traditional teaching methods in improving the mathematical proficiency of Grade 7 students under the MATATAG Curriculum.

Methodology

Research Design

This study will employ a descriptive quasi-experimental research design, which primarily aims to present a clear picture of the existing condition of a variable or phenomenon in a systematic manner. Descriptive research does not manipulate variables; instead, it provides a factual and accurate account of the current situation, serving as a foundation for deeper investigation (Tabuena et al., 2021). In this study, it will establish baseline information on the mathematical proficiency of Grade 7 learners and identify their strengths and weaknesses before any intervention. By doing so, the descriptive component will provide a comprehensive snapshot of learners' current performance in mathematics, which is essential for evaluating the impact of the instructional methods to be applied later. On the other hand, a quasi-experimental research design is a type of quantitative research in which the researcher examines the effect of an intervention on participants without random assignment to experimental and control groups, yet still involves comparison to assess cause-and-effect relationships (Larbi & Mavis, 2016). In this study, the quasi-experimental design involved two heterogeneous Grade 7 sections, intentionally selected: one assigned to the experimental group, which was taught using the Concrete-Pictorial-Abstract (CPA) method, and the other to the control group, which was taught using the traditional method. Because random assignment was not feasible, the study employed measures to establish comparability between the two groups. Specifically, the Grade 6 mathematics averages of the learners were examined to ensure that the experimental and control groups had relatively similar academic backgrounds prior to the intervention. In addition, pretest scores were

administered and analyzed to determine both groups' initial level of mathematical proficiency before implementing the instructional methods. The study compared mathematical proficiency using pretest and posttest scores. Specifically, this study employs a pretest-posttest nonequivalent control design to measure the effect of the instructional methods. While using intact classes may introduce threats to internal validity, such as selection bias and maturation, comparable groups and pretest measures helped minimize these threats and strengthen the credibility of the findings.

Research Participants

This study involved Grade 7 learners from a public secondary school in Davao City. Of the six Grade 7 sections, two heterogeneous classes, each with approximately 50 students, were selected as respondents. One class was taught using the Concrete-Pictorial-Abstract (CPA) method, while the other was taught using the traditional instructional method. Grade 7 learners were chosen because they are at a transitional stage from basic arithmetic to more abstract mathematical concepts, a shift that often leads to learning difficulties. The selected sections were intentionally chosen because they represented the diversity commonly found in regular classrooms (Garrett & Hong, 2016). As heterogeneous groups, students varied in academic performance, learning styles, and mathematical ability, making comparisons between the two teaching methods more realistic and applicable to typical classroom settings. The study excluded learners in Grades 8 to 10 from private schools. However, since the study was conducted in only one public secondary school in Davao City, the findings should be interpreted within this specific educational context. Consequently, the results may not generalize to other schools, regions, or educational settings.

This study employed purposive and universal sampling techniques. According to Etikan et al. (2016), purposive sampling is a non-probability sampling technique in which participants are intentionally selected based on characteristics relevant to the study. In contrast, universal sampling includes all members of the chosen population to ensure complete representation. In this study, purposive sampling was used to select two heterogeneous Grade 7 sections from six available sections under the researcher's supervision. Two sections were excluded—one special section and one under the Special Program for Foreign Language—leaving four heterogeneous sections, of which two were randomly chosen by lot. Heterogeneous classes are groups in which students have varied Grade 6 averages, representing high-performing, average, and struggling learners. The selected sections were assigned to either the CPA method or the traditional method, and all students in each section participated through universal sampling. All respondents completed both the pretest and posttest to ensure complete data for comparing the effectiveness of the two instructional methods.

Research Instrument

The researcher used a researcher-made questionnaire to gather data on students' mathematical proficiency. The instrument consisted of 96 multiple-choice items, with 8 items per topic covering Rectangular Pyramid, Square Pyramid, Sets, Real Numbers, Data and Sampling, Organizing Data and Graphs, Interpreting Graphs, Representing and Ordering Integers, Addition and Subtraction of Integers, Multiplication and Division of Integers, GEMDAS and Its Applications, and Absolute Value. Respondents selected the correct answer and wrote it in the space provided. This test served as the primary tool for assessing learners' understanding and mastery of the selected mathematical concepts. It underwent pilot testing and item analysis to ensure its quality and reliability. The instrument obtained an overall validity rating of 4.61, interpreted as "Excellent," indicating strong content validity, which is important for ensuring reliable research findings since well-developed instruments produce more accurate and credible results (Mohajan, 2017). During pilot testing, 10 items were initially developed for each topic, resulting in a total of 120 items administered to 52 Grade 7 students from heterogeneous classes answered the test items. Their responses were analyzed using item analysis, as defined by Manota (2025), a systematic statistical examination of learners' responses to determine item difficulty, discrimination, and reliability, ensuring that test items effectively differentiate levels of student performance. The difficulty index (p), ranging from 0.00 to 1.00, indicates the proportion of students who answered each item correctly and helps identify whether items are appropriate, faulty, or ineffective, thereby supporting validity and reliability (Kocdar et al., 2016). The difficulty index was used to evaluate each test item, wherein items with indices ranging from 0.25 to 0.75 were considered acceptable and retained, while those classified as very easy, easy, difficult, or very difficult were revised or discarded. In the first item analysis, 75 out of 120 items met the acceptable difficulty level and were retained, whereas the remaining 45 items were revised and subjected to a second cycle of pilot testing.

After the second item analysis, 40 revised items were found acceptable; however, only 21 of these were selected

to complement the 75 retained items from the first analysis, resulting in the final 96-item test instrument. This process ensured that each of the twelve mathematics topics was represented by eight well-performing items, producing a balanced and reliable instrument for assessing students' mathematical proficiency. Following the validation of the instrument, the intervention was implemented over a period of three (3) months, during which twelve (12) lessons corresponding to the twelve mathematics topics were delivered through daily one-hour instructional sessions. The same teacher facilitated both the Concrete-Pictorial-Abstract (CPA) and Traditional groups to maintain consistency in instruction and minimize teacher-related variability. For the CPA group, various instructional materials and manipulatives, including blocks, popsicle sticks, chips, bottled caps, number cards, number lines, tables, charts, and graphs, were used to promote conceptual understanding. To ensure instructional fidelity, all prepared lesson plans were implemented as designed, and a colleague teacher monitored classroom instruction using the Department of Education (DepEd) Classroom Observation Tool (COT) to verify the consistent implementation of the prescribed instructional procedures throughout the intervention. This refinement process ensured that only valid and reliable items were included in the final instrument used to assess students' mathematical proficiency. Learners' scores were interpreted using the Department of Education (DepEd) transmutation table, which classifies proficiency levels from Beginning (74% and below) to Advanced (90% and above), ensuring standardized and consistent evaluation of student performance and supporting the validity of the study's findings. To minimize potential researcher bias arising from the researcher's dual role as teacher and investigator, standardized procedures were followed during the administration of the pretest and posttest. Both groups received the same instructions, testing conditions, time allocation, and assessment procedures. In addition, scoring was based on a predetermined answer key and objective multiple-choice responses, reducing the possibility of subjective judgment during the evaluation process. The use of standardized scoring and uniform administration procedures helped maintain objectivity and strengthen the validity and reliability of the study's findings. After finalization, the test was administered to the selected classes, matched on Grade 6 Mathematics averages to ensure comparability between the experimental and control groups.

Data Gathering Procedure

The study followed approved procedures to ensure ethical compliance and research validity. The researcher first secured approval from the Dean of the Graduate School, then submitted and obtained approval from the Review Ethics Committee (REC). The researcher then obtained formal permission from the Schools Division Superintendent of Davao City to ensure adherence to institutional and ethical protocols. The researcher also sought content validation from Mathematics experts to ensure that the test items were appropriate, relevant, and aligned with the learning objectives. For the pilot testing phase, the researcher sent a permission letter to a public school in Davao City, where data were collected in person. After pilot testing, the researcher conducted item analysis to evaluate the quality and difficulty of the test items. After completing the preliminary procedures, the researcher obtained formal permission from the school's principal to conduct the study. The researcher provided assent letters to student respondents and distributed informed consent letters to their parents or guardians to ensure voluntary participation and ethical compliance. The researcher then administered the finalized questionnaire to the respondents, tabulated all collected data, and submitted it to a qualified statistician for appropriate statistical analysis. Finally, the researcher planned to submit the study findings for presentation in an international journal, with the paper intended for possible publication.

Data Analysis Procedure

This study employed a pretest-posttest design to measure students' mathematical proficiency before and after implementing the Concrete-Pictorial-Abstract (CPA) method and the Traditional Method of Instruction. Data were analyzed at a 0.05 level of significance using appropriate statistical tools to test the hypotheses. The mean, defined as the arithmetic average obtained by dividing the sum of all values by the number of observations (Kaur et al., 2018), was used to determine students' mathematical proficiency levels in both the pretest and posttest for the two instructional methods. Prior to conducting the inferential statistical analyses, the assumptions required for parametric testing were examined. Specifically, tests of normality were performed to determine whether the data were approximately normally distributed, while Levene's Test was used to assess the homogeneity of variance between groups. Verifying these assumptions helped ensure the data met the requirements for t-tests, supporting the appropriateness of the selected statistical procedures and strengthening the validity of the study's findings. In addition, a paired-samples t-test, which compares the means of two related groups to determine whether a significant difference exists (Salkind, 2017), was used to analyze pretest and posttest scores within each group to assess the intervention's effect. Furthermore, an independent sample t-test, used to compare the means of two independent groups to identify significant differences (Kim, 2019), was applied to the posttest results to

determine whether students taught using the CPA method performed significantly differently from those taught using the traditional method in terms of mathematical proficiency.

Ethical Considerations

To conduct the study titled “Concrete-Pictorial-Abstract and Traditional Method of Instruction in Enhancing Mathematical Proficiency among Grade 7 Learners,” several ethical considerations were strictly followed. Participants were fully informed about the study and participated voluntarily, with their identities kept anonymous and all personal data handled with strict confidentiality. The informed consent process, which is an internationally recognized ethical standard (Wu et al., 2024), involved obtaining written consent from parents or guardians and assent from students before administering the pretest and posttest. The study also underwent review and approval by the Research Review and Ethics Committee to ensure compliance with ethical standards and protection of participants’ rights, safety, and voluntary participation. Anonymity was ensured by using codes rather than names, meaning participants’ identities cannot be linked to their responses (Czarnota-Bojarska, 2021). In addition, confidentiality and data privacy were maintained by securing all records and ensuring that no identifying information was disclosed, consistent with ethical principles that protect participants’ personal information from unauthorized access or disclosure (Kang & Hwang, 2023). Furthermore, all collected data were securely stored in a locked box accessible only to the researcher and will be properly destroyed after two years. An Artificial Intelligence Usage Declaration was also observed, emphasizing that AI was not used in the formulation, analysis, scoring, or interpretation of data to ensure accuracy, integrity, and transparency of results. Ethical AI use involves fairness, accountability, and respect for human dignity (Camilleri, 2024), and in this study, all findings were based solely on participants’ actual responses and standard statistical procedures. By adhering to these ethical considerations, the study respected participants and maintained the integrity and credibility of the research process.

Results and Discussion

Mathematical Proficiency of Grade 7 Students

Before and After Using the Traditional Method

This study examines students' levels of mathematical proficiency. Table 1 presents the pretest and posttest results using the traditional teaching method, reflecting learners’ mathematical proficiency before and after instruction.

Table 1. Level of Mathematical Proficiency of Grade 7 Students Before and After the Implementation of the Traditional Method of Instruction		
Teaching Approach	Mean Score (Before & After)	Interpretation
Traditional Method	40.36	The student in this score is at the Beginning Level. The student struggles with his/her understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding.
	47.84	The student in this score is still at the Beginning Level. The student struggles with his/her understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding.

Before instruction using the traditional approach, the learners’ pretest mean score of 40.36 reflects a generally low-performance level in mathematics, which is similar to findings of Dela Peña and Doronio (2025), where students taught through conventional methods often demonstrate low baseline achievement in pre-instruction assessments (e.g., control groups in mathematics performance studies show low pretest means). Traditional, teacher-centered instructional approaches have been associated with limited initial conceptual understanding among learners before intervention (Kozanitis & Nenciovici, 2023). These patterns of low pretest performance under conventional instruction highlight common challenges in engaging students’ mathematical understanding before implementing structured or innovative teaching strategies.

The learners’ posttest mean score of 47.84 under the traditional method shows a slight improvement from the pretest. However, it remains within the lower performance range according to the DepEd table, indicating continued difficulty in mastering the targeted mathematical concepts. In many classroom settings, teachers struggle to clearly explain mathematical concepts and ensure students’ understanding, as instruction largely depends on textbooks and teacher-led discussions. Libo-on and Perez (2021) note that while lecture-based instruction can produce learning gains, these are often modest compared with more structured or interactive strategies. Lee and Paul (2023) further explain that traditional methods emphasize teacher-centered delivery and

routine practice, which can limit student engagement and deeper understanding. In addition, classroom observations suggest that students often lack sufficient opportunities to demonstrate their capabilities, as learning tasks tend to emphasize passive reception over active participation. Meanwhile, Chen (2025) notes that such standardized, less individualized instruction fails to address diverse learning needs, while Khasawneh et al. (2023) highlight that it often positions students as passive learners with limited opportunities for active participation and problem-solving. Overall, despite slight improvement, many learners still struggled to understand and apply the concepts, underscoring the limitations of traditional, teacher-centered instruction in promoting deeper learning.

Before and After Using the CPA Method

Table 2 presents the mean scores reflecting Grade 7 students' level of mathematical proficiency before and after implementing the CPA instructional method. The table shows pretest and posttest performance in mathematical proficiency following instruction using the Concrete-Pictorial-Abstract (CPA) method. Before the CPA method was introduced, the learners' pretest mean score of 38.02 indicates a generally low level of understanding in mathematics, consistent with descriptive findings by Galope and Gumanoy (2025), who found that students demonstrate low baseline performance in mathematics prior to instruction using structured methods.

Table 2. *Level of Mathematical Proficiency of Grade 7 Students Before and After the Implementation of the CPA Method of Instruction*

Teaching Approach	Mean Score (Before & After)	Interpretation
CPA Method	38.02	The student in this score is at the Beginning Level. The student struggles with his/her understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding.
	55.78	The student in this score is still at the Beginning Level. Students struggle with understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding.

The CPA strategy, which progresses from concrete to pictorial to abstract representations, is intended to scaffold learners' conceptual understanding; however, low pretest scores often reflect gaps in students' readiness and prior mathematical knowledge prior to intervention (Agustin, 2023). This initial performance suggests that most learners had not yet developed the foundational competencies targeted by the CPA approach prior to its implementation. Despite implementing the CPA method, the posttest results remained at the beginning level, indicating limited overall improvement in mathematical proficiency. This may be influenced by challenges in instructional delivery, including limited opportunities for seminars or professional training focused on CPA implementation, which can affect teaching effectiveness. Pham et al. (2025) emphasized that teacher competency and insufficient professional development may hinder the effective use of CPA in instruction. In addition, a lack of adequate learning materials and manipulatives often requires teachers to use improvised resources, which may limit students' engagement in the concrete and pictorial stages (Tjandra, 2023). Gaps in teacher training and instructional planning also contribute to the limited integration of CPA strategies in classroom practice, which may be associated with low student achievement (Gabina et al., 2021).

In contrast, the learners' posttest mean score of 55.78 indicates improved mathematics performance after implementing the CPA method. Studies suggest that CPA instruction, which moves from concrete manipulatives to pictorial representations and then to abstract reasoning, enhances conceptual understanding and problem-solving skills and often leads to improved posttest outcomes (Putri et al., 2020). Similarly, Suryaningsih et al. (2025) found that students exposed to CPA performed better in mathematics compared to those taught using traditional methods. These findings indicate that CPA provides a structured learning pathway that helps students develop a better understanding and application of mathematical concepts.

Difference in Mathematical Proficiency

Before and After Traditional Instruction

To determine the impact of the traditional teaching method, students' mathematical proficiency was assessed before and after instruction. Similarly, Table 3 shows that the paired-samples t-test revealed a statistically significant difference in mathematical proficiency before and after implementing the traditional instructional method.

Table 3. *Difference in Mathematical Proficiency Before and After the Traditional Method of Instruction*

Table 3. Difference in Mathematical Proficiency Before and After the Traditional Method of Instruction								
Pair 2	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Traditional-Before - Traditional-After	-7.48	9.32	1.32	-10.13	-4.83	-5.67	49	<.001

The mean score increased from 40.36 ($SD = 10.67$) before instruction to 47.84 ($SD = 14.35$) after instruction, indicating a mean improvement of 7.48 points. This difference was supported by a t -value of -5.67 with 49 degrees of freedom and a p -value of $< .001$, which is statistically significant at the .05 level. The 95% confidence interval for the mean difference (-10.13 to -4.83) also excludes zero, indicating rejection of the null hypothesis. Therefore, it is concluded that a significant difference exists in students' mathematical proficiency before and after the implementation of the traditional method of instruction. In terms of variability, the standard deviation increased from 10.67 (pretest) to 14.35 (posttest), indicating greater score dispersion after instruction. This suggests that students' responses to the traditional teaching approach were less uniform, with some students improving while others made limited gains. The result indicates that although the traditional approach to teaching mathematics is less effective, it still contributes to learners' understanding to a limited extent. Traditional instruction has been shown to improve students' conceptual understanding in mathematics, though the gains are generally limited (Dairo et al., 2024). Comparative findings indicate that, while learning occurs, students taught through traditional methods tend to achieve lower outcomes than those taught through more innovative instructional methods (Pelayo, 2024). Corrêa and Haslam (2021) show that open-ended, student-led, and problem-based mathematics tasks contribute more positively to students' mathematical proficiency than the traditional teacher-centered instructional model.

Research indicates that traditional instructional methods can improve students' mathematical proficiency, even though the gains are generally limited. Studies have shown significant increases in students' posttest scores after receiving conventional instruction, demonstrating that learners benefit from structured, teacher-led lessons (Dela Peña & Doronio, 2025). Learners taught using traditional methods also showed significant improvements in mathematical literacy (Latumbo, 2024). In a study examining the effectiveness of innovative teaching strategies, the control group, taught using traditional methods, still showed meaningful improvements in mathematics performance (Nida et al., 2020). These findings suggest that while traditional methods positively impact learning outcomes, they may not maximize conceptual understanding or greater problem-solving skills.

Before and After the Implementation of the CPA Method

The results show how students' mathematical proficiency changed following the CPA method intervention. Table 4 shows that the paired-samples t -test results indicate a statistically significant difference in students' mathematical proficiency before and after implementing the Concrete-Pictorial-Abstract (CPA) instructional method.

Table 4. *Difference in Mathematical Proficiency Before and After the Implementation of the CPA Method*

Table 2: Difference in Mathematical Proficiency Before and After the Implementation of the CPA Method								
Pair 1	Paired Differences					T	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
CPA-Before - CPA-After	-17.76	10.32	1.46	-20.69	-14.83	-12.17	49	<.001

As reflected in the descriptive statistics, the mean score increased markedly from 38.02 ($SD = 7.11$) prior to the intervention to 55.78 ($SD = 13.17$) after the intervention, representing a mean gain of 17.76 points. This improvement was statistically confirmed by the paired-samples t -test, which yielded a t -value of -12.17 with 49 degrees of freedom and a p -value of $< .001$, well below the .05 level of significance. The 95% confidence interval for the mean difference (-20.69 to -14.83) does not include zero, indicating that the observed increase in mathematical proficiency is not attributable to chance. Thus, the null hypothesis is rejected, indicating that a significant difference in students' mathematical proficiency exists between the pre- and post-implementation stages of the CPA method. Regarding variability, the change in standard deviation from 7.11 (pretest) to 13.17 (post-test) suggests that while the CPA method significantly improved overall mathematical proficiency, students benefited from the intervention to varying degrees. This increased dispersion indicates differentiated learning

gains, with some students achieving substantial improvements while others showing more moderate progress (Palomares & Gonzalvo, 2025). Importantly, the greater variability occurred alongside a large increase in the mean score, suggesting that the CPA method was broadly effective while allowing for individual differences in learning trajectories (Estrada et al., 2019).

The results indicate that the CPA method is an appropriate teaching approach for helping students achieve higher attainment in mathematics. The significant improvement in mean scores from pre- to post-test provides evidence that an organized transition from concrete to pictorial and abstract forms promotes better understanding of mathematical concepts (Agusta, 2025). This aligns with a previous study that found CPA instruction helps students make sense of mathematical concepts and representations, leading to better learning outcomes (Putri et al., 2020; Suryaningsih et al., 2025). Effective mathematics instruction requires well-sequenced learning experiences, and implementing the CPA method over several lessons gradually allows students to move from concrete to abstract understanding. Adequate time supports learners’ readiness at each stage and strengthens their overall understanding of mathematical concepts (Shuxratovna, 2024). The results further indicate that learners show increased motivation to learn mathematics when taught using the Concrete–Pictorial–Abstract (CPA) method.

Supporting this finding, Iyamuremye and Burns (2025) reported that CPA instruction effectively enhances learners’ motivation and mathematical achievement, particularly in specific mathematics content areas. The findings also suggest that learners demonstrate improved retention of numeracy skills (Chasanah et al., 2024) following instruction using the Concrete–Pictorial–Abstract (CPA) approach, as this method supports more effective recall of mathematical concepts through structured, meaningful representations. Thus, the CPA approach not only enhances overall mathematical proficiency but also accommodates individual differences in students’ learning trajectories (Leyson & Andrino, 2025). Overall, these findings confirm that the CPA method significantly improves students’ mathematical understanding, motivation, retention, and ability to progress from concrete to abstract reasoning.

Difference in Mathematical Proficiency Between Using CPA and Traditional Methods of Instruction

Table 5 shows that, in the group statistics, students taught using the CPA method had a higher mean mathematical proficiency score ($M = 55.78$, $SD = 13.17$) than those taught using the traditional method ($M = 47.84$, $SD = 14.35$).

Table 5. *Difference in the Mathematical Proficiency Between Using CPA and Using the Traditional Method of Instruction*

Mathematical Proficiency	Independent Samples Test								
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.07	.303	2.88	98.00	.005	7.94	2.75	2.48	13.41
Equal variances not assumed			2.88	97.28	.005	7.94	2.75	2.47	13.41

This initial comparison suggests that students exposed to the CPA method performed better on average than those taught using the traditional method. Both groups showed relatively high standard deviations, indicating variability in students’ performance levels. However, the CPA group showed a slightly lower standard deviation, suggesting more consistent learning outcomes than the traditional group, although variability remained in both instructional methods. Levene’s Test for Equality of Variances yielded a non-significant result ($F = 1.07$, $p = .303$), indicating that the assumption of homogeneity of variances was met. Therefore, we assumed equal variances for further analysis. The independent samples t-test showed a statistically significant difference between the two groups, with $t = 2.88$, $df = 98$, and $p = .005$, which is below the .05 level of significance. The mean difference of 7.94 points indicates that students taught using the CPA method performed significantly better than those taught using the traditional method. The 95% confidence interval (2.47 to 13.41) did not include zero, confirming that the difference is statistically meaningful and not due to chance. Based on these results, the null hypothesis was rejected, showing that CPA is more effective than the traditional method in improving students’ mathematical proficiency. The results also suggest that while both groups had performance variability, CPA produced higher achievement with slightly more consistent outcomes.

The findings further support CPA instruction to improve mathematical learning outcomes. Studies show that CPA learners achieve higher posttest scores and greater engagement compared to those in traditional instruction (Rozata & Theoneste, 2024). This improvement is linked to the structured progression from concrete to pictorial to abstract learning, which builds strong conceptual understanding before abstract problem-solving (Akinoso, 2015; Mudaly & Naidoo, 2015). CPA also promotes active learning and critical thinking, helping students internalize mathematical concepts better than rote-based instruction (Robert, 2020). In addition, CPA improves procedural fluency, problem-solving skills, and mathematical reasoning, enabling learners to apply concepts more effectively in new situations (Nugroho & Jailani, 2019; Salingay & Tan, 2018; Camañan, 2019). Overall, the results indicate that CPA provides a more effective learning pathway than traditional instruction, particularly in developing deeper understanding and higher-order thinking skills. This aligns with research showing that CPA-based instructional materials enhance conceptual understanding and support teacher effectiveness and creativity (Mas'udah & Utaminingsih, 2024). Theoretically, these findings are supported by Bruner's theory of representation and Vygotsky's Activity Theory, which emphasize learning through structured progression and active engagement. Consistent with these frameworks, students exposed to CPA achieved significantly higher posttest scores. They demonstrated greater engagement than those taught using traditional methods, confirming that CPA-based instruction improves mathematical proficiency and understanding (Iyamuremye & Burns, 2025).

Prior to conducting the Analysis of Covariance (ANCOVA), Levene's Test of Equality of Error Variances was performed to assess the assumption of homogeneity of variances. The result was not statistically significant, $F(1, 98) = 0.672, p = .414$, indicating that the assumption of equal error variances was satisfied. Therefore, the data met the homogeneity-of-variance assumption required for ANCOVA.

Table 6 presents the results of the one-way analysis of covariance (ANCOVA) comparing the posttest mathematical proficiency scores of the CPA and Traditional Method groups while controlling for pretest scores.

Table 6. Results Comparing Posttest Mathematical Proficiency Scores of the CPA and Traditional Method Groups After Controlling for Pretest Scores

	Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^a
Contrast	2675.251	1	2675.251	27.479	.000	.221	27.479	.999
Error	9443.571	97	97.356					

The F tests the effect of GROUP. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Computed using alpha = .05

A one-way analysis of covariance (ANCOVA) was conducted to determine whether posttest mathematical proficiency scores differed significantly between the Concrete-Pictorial-Abstract (CPA) and Traditional Method groups after controlling for pretest scores. The results indicated that the instructional method had a statistically significant effect on posttest scores after adjusting for pretest performance, $F(1,97)=27.48, p<.001$, partial $\eta^2=.221$. The effect size was large, indicating that the instructional method explained approximately 22.1% of the variance in posttest scores after controlling for pretest scores. The observed power was .999, indicating that the analysis had a very high probability of detecting the observed effect.

Pairwise comparisons of the adjusted posttest means indicated that learners taught using the Concrete-Pictorial-Abstract (CPA) method achieved significantly higher mathematical proficiency scores than those taught using the Traditional Method after controlling for pretest scores. The adjusted mean difference between the two groups was 10.432 points [95% CI (6.482, 14.382)], indicating that learners in the CPA group scored, on average, 10.43 points higher than those in the Traditional group after adjustment for baseline differences. Because the confidence interval did not include zero, the difference between the two instructional methods was statistically significant.

This finding is consistent with previous research showing that the Concrete-Pictorial-Abstract (CPA) method is more effective than the traditional method in improving students' mathematics achievement. Salingay and Tan (2020) reported that students exposed to CPA achieved significantly higher mathematics performance and retention scores, indicating the method's positive impact on mathematics achievement. Furthermore, systematic reviews support the effectiveness of CPA across various educational levels. Azzumar and Juandi (2023) concluded that CPA consistently improves mathematics learning outcomes, with learners generally performing better than those taught through traditional methods. Similarly, Lutfi and Dasari (2024), through a review of 39 studies, found that CPA positively influences students' mathematical abilities and academic outcomes, with CPA-taught learners

demonstrating superior mathematics performance compared to their counterparts receiving conventional instruction. The significant effect of CPA on mathematical proficiency supports the view that instruction grounded in meaningful learning activities and multiple representations enhances learners' achievement in mathematics. Consistent with Bruner's Theory of Representation and Vygotsky's Activity Theory, the CPA method provides learners with concrete and symbolic tools that facilitate the development of mathematical proficiency, resulting in significantly higher performance than traditional instruction.

Conclusion

Based on the findings, Grade 7 learners in both the traditional and Concrete-Pictorial-Abstract (CPA) groups were initially classified at the Beginning level of mathematical proficiency based on DepEd standards. Following instruction, both groups obtained higher posttest scores, and the improvements within each group were statistically significant. This indicates that both teaching methods were associated with improved performance on the mathematical test under the study conditions. However, learners exposed to the CPA method demonstrated significantly greater improvement than those taught using the traditional method. Despite these gains, both groups remained within the Beginning proficiency category after instruction. Therefore, the findings suggest that the CPA method produced larger gains in mathematical proficiency test scores than the traditional method among the learners included in this study. Nevertheless, the results should not be interpreted as evidence of improvement in conceptual understanding, problem-solving skills, retention, or engagement because these outcomes were not measured separately. Further instruction and additional learning support may be necessary for learners to progress to higher proficiency levels.

Contributions of Authors

Author 1: conceptualization, data gathering, data analysis

Author 2: data analysis, data interpretation

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References

- Agusta, E.S. (2025). Enhancing students' understanding of mathematical concepts through the concrete-pictorial-abstract (CPA) approach in learning fractions. *ALGORITMA: Journal of Mathematics Education*, 7(1), 55–65.
- Agustin, G. (2023). Concrete pictorial abstract (CPA) approach in mathematics problem solving. *International Advanced Research Journal in Science, Engineering and Technology (IARJSET)*, 10(7), 658–662. <https://doi.org/10.17148/IARJSET.2023.107109>
- Ahmad, S., & Siller, H.-S. (2024). Investigating the effect of manipulatives on mathematics achievement: The role of concrete and virtual manipulatives for diverse achievement level groups. *Journal on Mathematics Education*, 15(3), 979–1002. <https://doi.org/10.22342/jme.v15i3.pp979-1002>
- Akinoso, S.O. (2015). Teaching mathematics in a volatile, uncertain, complex and ambiguous (VUCA) world: The use of concrete-representational-abstract instructional strategy. *Journal of Education and Practice*, 19(1), 97–107. <https://files.eric.ed.gov/fulltext/EJ1177074.pdf>
- Angco, R.J., & Angco, L. (2024). A meta-synthesis of effective practices and outcomes in the use of manipulatives for teaching mathematics. *Human Behavior, Development & Society*, 25(2). <https://doi.org/10.62370/hbds.v25i2.274848>
- Azzumar, F., & Juandi, D. (2023). Concrete-pictorial-abstract approaches to mathematics education: A systematic literature review. *Journal of Mathematics and Mathematics Education*, 13(1), 1–11.
- Binatlao, H., & Cordova, C. (2025). Assessing students' problem-solving skills in concrete-representational-abstract approach. *Journal of Education and Sociology*, 4(6), 28–34. <https://doi.org/10.5281/zenodo.15579215>
- Bruner, J. (1974). *Toward a theory of instruction*. Harvard University Press. <https://tinyurl.com/dpyj789z>
- Camañan, C.T. (2019). Employing concrete-representation-abstract approach in enhancing mathematics performance. *SLONGAN*, 4(1), 25. <https://rpo.cjc.edu.ph/index.php/slongan/article/view/21>
- Camilleri, M.A. (2024). Artificial intelligence governance: Ethical considerations and implications for social responsibility. *Expert Systems*, 41(7), e13406. <https://doi.org/10.1111/essy.13406>
- Canto López, M.D.C., Manchado Porras, M., Piñero Charlo, J.C., Mera Cantillo, C., Delgado Casas, C., Aragón Mendizábal, E., & García Sedeño, M.A. (2022). Description of main innovative and alternative methodologies for mathematical learning of written algorithms in primary education. *Frontiers in Psychology*, 13, 913536. <https://doi.org/10.3389/fpsyg.2022.913536>
- Chasanah, U., Wibowo, W.C., Supriatna, U., & Riyandi, W.B. (2024). Improving students' numeracy skills using the CPA (concrete, pictorial, abstract) approach in number material for 2nd grade at MIN 1 Batam. *Jurnal Profesionalisme Guru*, 1(4), 577–582.
- Chen, X. (2025). A comparative study on the effectiveness of traditional and modern teaching methods. *Lecture Notes in Education Psychology and Public Media*, 85, 13–18. <https://doi.org/10.54254/2753-7048/2025.20824>
- Corréa, P.D., & Haslam, D. (2021). Mathematical proficiency as the basis for assessment: A literature review and its potentialities. *Mathematics Teaching Research Journal*, 12(4), 3–20.
- Czarnota-Bojarska, J. (2021). The ethics of organizational research: Methodological considerations for ensuring respondents' anonymity and confidentiality. *EWOP in Practice*, 15(1). <https://doi.org/10.21825/ewopinpractice.87141>
- Dairo, N.O.M., Okonkwo, N.C.A., & Orakwe, N.C.U. (2024). A review of primary school teachers' insight into traditional instruction and activity-based learning in mathematics education. *International Journal of Applied Research in Social Sciences*, 6(11), 2778–2790. <https://doi.org/10.51594/ijarss.v6i11.1725>
- Dela Peña, R.M.J., & Doronio, R. (2025). An experimental study on mathematics teaching strategies and academic performance of students. *International Journal of Research and Innovation in Social Science*. <https://dx.doi.org/10.4772/IJRIS.2025.90700097>
- Estrada, E., Ferrer, E., & Pardo, A. (2019). Statistics for evaluating pre-post change: Relation between change in the distribution center and change in the individual scores. *Frontiers in Psychology*, 9, 2696. <https://doi.org/10.3389/fpsyg.2018.02696>

- Etikan, I., Musa, S.A., & Alkassim, R.S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1–4. <https://doi.org/10.11648/j.ajtas.20160501.11>
- Evans, B.J., Bettinger, E.P., & Antonio, A.L. (2025). Data collection and monitoring in an educational RCT of a postsecondary access program: Assessing internal and external validity. *Education Sciences*, 15(3), 363. <https://doi.org/10.3390/educsci15030363>
- Gabina, S., Jagri, B., Mohammed, A.A., Anass, A.A., Abdul-Mumin, A.H., Agyei, E., & Domonaamwin, C.B. (2021). Factors affecting efficient teaching and learning of mathematics in senior high schools in Wa. *Teacher Education and Curriculum Studies*, 6(3), 81–88. <https://doi.org/10.11648/j.tecs.20210603.11>
- Galope, G., & Gumanoy, R. (2025). Mathematics mastery through innovative pedagogical approaches. *International Journal of Research and Innovation in Applied Science*, 10(2), 442–452. <https://doi.org/10.51584/IJRIAS.2025.10020040>
- Garrett, R., & Hong, G. (2016). Impacts of grouping and time on the math learning of language minority kindergartners. *Educational Evaluation and Policy Analysis*, 38(2), 222–244. <https://doi.org/10.3102/0162373715611484>
- Ines, J. (2023, December 5). PH still among lowest in math, science, reading in global student assessment. *Rappler*. <https://tinyurl.com/bddbb4mk>
- Iyamuremye, E., & Burns, D. (2025). Concrete-pictorial-abstract instruction: Enhancing students' learning motivation and achievement in mathematics. *Cogent Education*, 12(1), 2558303. <https://doi.org/10.1080/2331186X.2025.2558303>
- Kang, E., & Hwang, H.-J. (2023). The importance of anonymity and confidentiality for conducting survey research. *Journal of Research and Publication Ethics*, 4(1), 1–7. <https://doi.org/10.15722/JRPE.4.1.202303.1>
- Kaur, P., Stoltzfus, J., & Yellapu, V. (2018). Descriptive statistics. *International Journal of Academic Medicine*, 4(1), 60–63. https://doi.org/10.4103/IJAM.IJAM_7_18
- Khasawneh, E., Hodge-Zickerman, A., York, C., Smith, T., & Mayall, H. (2023). Examining the effect of inquiry-based learning versus traditional lecture-based learning on students' achievement in college algebra. *International Electronic Journal of Mathematics Education*, 18(1), em0724. <https://doi.org/10.29333/iejme/12715>
- Kim, H.-Y. (2019). Statistical notes for clinical researchers: The independent samples t-test. *Restorative Dentistry & Endodontics*, 44(3), e26. <https://doi.org/10.5395/rde.2019.44.e26>
- Kocdar, S., Karadag, N., & Sahin, M.D. (2016). Analysis of the difficulty and discrimination indices of multiple-choice questions according to cognitive levels in an open and distance learning context. *Turkish Online Journal of Educational Technology-TOJET*, 15(4), 16–24. <https://www.tojet.net/articles/v15i4/1542.pdf>
- Kozanitis, A., & Nenciovici, L. (2023). Effect of active learning versus traditional lecturing on the learning achievement of college students in humanities and social sciences: A meta-analysis. *Higher Education*, 86(6), 1377–1394. <https://doi.org/10.1007/s10734-022-00977-8>
- Larbi, E., & Mavis, O. (2016). The use of manipulatives in mathematics education. *Journal of Education and Practice*, 7(36), 53–61. <https://tinyurl.com/ymndzmbv>
- Latumbo, I.L. (2024). Differentiated instruction in teaching fourth grade mathematics: Basis for an instructional module. *Psychology and Education: A Multidisciplinary Journal*, 17(6), 1–1. <https://scimatic.org/storage/journals/11/pdfs/2603.pdf>
- Lee, J., & Paul, N. (2023). A review of pedagogical approaches for improved engagement and learning outcomes in mathematics. *Journal of Student Research*, 12(3), 1–9.
- Leong, Y.H., Ho, W.K., & Cheng, L.P. (2015). Concrete-pictorial-abstract: Surveying its origins and charting its future. <https://tinyurl.com/3bnmc4pn>
- Leyson, J., & Andriano, V. (2025). Enhancing pupils' learning in mathematics through the use of concrete-pictorial-abstract approach. *International Journal of Research and Innovation in Social Science*, 8(12), 1937–1951. <https://doi.org/10.47772/ijriss.2024.8120165>
- Libo-on, J., & Perez, J. (2021). Effects of four teaching strategies on the academic performance of senior high school students. *Romblon State University Research Journal*, 3(2), 22–30. <https://doi.org/10.58780/rsurj.v3i2.60>
- Lutfi, J.S., & Dasari, D. (2024). Research trends on learning mathematics with the CPA (Concrete-Pictorial-Abstract) approach. *Prisma*, 13(1), 103–112.
- Manota, A.C. (2025). Acceptability of the developed spreadsheet-based item analysis tool. <https://tinyurl.com/b58pa8uz>
- Mas'udah, S., & Utaminingsih, S. (2024). Development of mathematics textbook based on the concrete, pictorial, abstract (CPA) number approach for MI students in Sedan District, Rembang City. *Uniglobal Journal of Social Sciences and Humanities*, 3(1), 107–111. <https://doi.org/10.53797/ujssh.v3i1.16.2024>
- Mizzi, D., & Calleja, J. (2024). Using lesson study to implement the CPA approach in a mathematics primary classroom. <https://www.um.edu.mt/library/oar/handle/123456789/129978>
- Mohajan, H.K. (2017). Two criteria for good measurements in research: Validity and reliability. *Annals of Spiru Haret University: Economic Series*, 17(4), 59–82. <https://doi.org/10.26458/1746>
- Mudaly, V., & Naidoo, J. (2015). The concrete-representational-abstract sequence of instruction in mathematics classrooms. *Perspectives in Education*, 33(1), 42–56. <https://doi.org/10.38140/pie.v33i1.1895>
- Nida, N.K., Usodo, B., & Saputro, D.R.S. (2020, May). Effectiveness of the flipped classroom model on the students' mathematical creative thinking skills. In *International Conference on Online and Blended Learning 2019 (ICOBL 2019)* (pp. 107–110). Atlantis Press. <https://doi.org/10.2991/assehr.k.200521.022>
- Nugroho, S.A., & Jailani, J. (2019). The effectiveness of concrete representational abstract (CRA) approach and problem solving approach on mathematical representation ability at elementary school. <https://doi.org/10.18502/KSS.V3i17.4620>
- OECD. (2023). PISA 2022 results (Volume I): The state of learning and equity in education. PISA, OECD Publishing. <https://doi.org/10.1787/53f23881-en>
- Ouyang, B. (2023). Efficacy of problem-based learning over traditional pedagogy on US CPA practice exam performance among Chinese accounting university students (Doctoral dissertation, Walden University).
- Palomares, N., & Gonzalvo, I. (2025). Learning gaps in Mathematics 7 and teachers' instructional strategies in selected public secondary schools in the second congressional district of Quezon. *Psychology and Education: A Multidisciplinary Journal*, 48(3), 327–341. <https://doi.org/10.70838/pemj.480303>
- Pelayo, E.O. (2024). The effect of social based-trends instruction to students' conceptual understanding in mathematics. *Indonesian Journal of Education Research (IJoER)*, 5(6), 324–330. <https://doi.org/10.37251/ijer.v5i6.1303>
- Pham, H.T.H., Pham, Q.D., Bui, C.K., & Le, H.T. (2025). Factors affecting the effectiveness of math teachers' integrated teaching in secondary schools: The case of Vietnam. *Journal of Pedagogical Research*, 9(1), 235–253. <https://doi.org/10.33902/jpr.202532448>
- Prosser, S., & Bismarck, S. (2023). Concrete-representational-abstract (CRA) instructional approach in an Algebra I inclusion class: Knowledge retention versus students' perception. *Education Sciences*, 13(10), 1061. <https://doi.org/10.3390/educsci13101061>
- Putri, H.E., Suwangsih, E., Rahayu, P., Nikawanti, G., Enzelina, E., & Wahyudy, M.A. (2020, April). Influence of concrete-pictorial-abstract (CPA) approach on the enhancement of primary school students' mathematical reasoning ability. *Mimbar Sekolah Dasar*, 7(1), 119–132. <https://doi.org/10.17509/mimbar-sd.v7i1.22574>
- Reyes, J.D. (2021). Effectiveness of concrete-representational-abstract sequence of instruction in probability on select-groups of eight graders. *International Journal of Multidisciplinary Research and Growth Evaluation*, 2(1), 438–443.
- ROBERT, P. (2020). A study to foster proactive learning in mathematics at primary schools in the Republic of the Marshall Islands through concrete-pictorial-abstract (CPA) approach. *International Cooperation Center for the Teacher Education and Training, Naruto University of Education*. <https://doi.org/10.24727/00028532>
- Rozata, U., & Theoneste, H. (2024). Concrete pictorial abstract approach use in teaching mathematics on secondary students' participation in six selected schools in Kicukiro District, Rwanda. *African Journal of Empirical Research*, 5(4), 1243–1251. <https://doi.org/10.51867/ajernet.5.4.102>
- Salingay, N., & Tan, D. (2018). Concrete-pictorial-abstract approach on students' attitude and performance in mathematics. *International Journal of Scientific & Technology Research*, 7(5), 90–111.
- Salkind, N. (2017). *Statistics for people who (think they) hate statistics* (6th ed.). SAGE Publications. <https://tinyurl.com/yjpdhaw6>
- Shafiee, M.S., & Meng, C.C. (2023). Impact of concrete-pictorial-abstract approach with collaborative lesson research on year four pupils' proficiency in volume. *Asia Pacific Journal of Educators and Education*, 38(1), 119–140. <https://doi.org/10.21315/apjee.2023.38.1.7>
- Shuxratovna, R.N. (2024). Pedagogical possibilities of implementing the CPA (concrete-pictorial-abstract) approach. *International Journal of Pedagogics*, 4(2), 68–76. <https://doi.org/10.37547/ijp/Volume04Issue02-13>
- Suryaningsih, T., Nisa, K., Widiyanto, R., Latip, A.E., & Siron, Y. (2025). Enhancing elementary students' numeracy skills through the concrete pictorial abstract (CPA) approach. *Journal of Integrated Elementary Education*, 5(1), 224–236. <https://doi.org/10.21580/jieed.v5i1.25383>
- Tabuena, A.C., Hilario, Y.M., & Buenafior, M. (2021). Overview and exemplar components of the research methodology on the research writing process for senior high school students. *International Journal of Trend in Scientific Research and Development*, 5(3), 117–126. <https://doi.org/10.2139/ssrn.3802722>
- Tenzin, S. (2024). The implementation of the concrete-pictorial-abstract (CPA) instructional model in teaching primary mathematics in Thimphu Dzongkhag. *RABSEL*, 25(1). <https://doi.org/10.5281/zenodo.14524332>
- Tjandra, C. (2023). Effectiveness of using manipulatives in mathematics teaching in inclusive education programs in an elementary school. *Dharmas Education Journal (DE_Journal)*, 4(1), 168–178. <https://tinyurl.com/4csbspah>
- Vygotsky, L.S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard University Press.
- Wu, C., Wang, N., Wang, Q., Wang, C., Wei, Z., Wu, Z., Yu, S., & Jiang, X. (2024). Participants' understanding of informed consent in clinical trials: A systematic review and updated meta-analysis. *PLoS ONE*, 19(1), e0295784. <https://doi.org/10.1371/journal.pone.0295784>