EduHeart Knowledge Network and Publishing, Inc.
DOI: https://doi.org/10.66206/eduheart.2026.298
Asian Research Journal of Education, 2026
E-ISSN: 3028-0842
P-ISSN: 3028-0834
Vol. 3 No. 2

Employing Cognitively Guided Instruction in Mathematics Using the Concrete–Pictorial–Abstract Approach to Develop the Problem-Solving Skills of Grade 2 Pupils

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ABSTRACT

This descriptive action research investigated the impact of Cognitively Guided Instruction (CGI) principles combined with the Concrete–Pictorial–Abstract (CPA) Approach on the development of mathematical thinking among Grade 2 pupils' conceptual understanding *and procedural knowledge of the four fundamental operations. The study utilized a non-directive, facilitative instructional model where the teacher provided targeted prompts rather than direct instruction, allowing pupils to transition from concrete modeling to abstract algorithmic solutions across three assessment phases. Key findings revealed that twelve (12) of the 15 Grade 2 pupils achieved an Above Average Level of performance, while the remaining three reached the Average Level, demonstrating significant growth in terms of problem-solving comprehension, modeling techniques used, solution strategies used, and accuracy of the solution and answer. Both quantitative and qualitative data gathered confirmed that the use of CGI problem types—supported by linguistic translations in English and Filipino—showed the attainment of the goals set, which are to develop the (a) conceptual understanding of the mathematical operations as the pupils explain the solution strategy they used and as they give accurate answers; and (b) procedural understanding of the four fundamental operations by using the appropriate mathematical algorithm as a solution for the word problems. By allowing pupils to internalize mathematical logic through their own invented strategies, the research successfully documented a clear developmental trajectory from intuitive physical representation to formal mathematical abstraction. The study recommends the use of CGI using the CPA approach in the teaching of the four fundamental operations, to reach the level of abstraction and understanding of the four fundamental operations procedurally and conceptually.*

Keywords: *Cognitively Guided Instruction, concrete-pictorial-abstract approach, problem-solving skills, conceptual understanding, procedural knowledge*

INTRODUCTION

The traditional paradigm of mathematics education, which emphasized rote memorization and rigid step-by-step procedures, is being replaced by a focus on exploration and experimentation. Modern research suggests that mathematics should serve as a space where pupils share ideas and construct their own meaning rather than simply replicating teacher-led algorithms. By acknowledging that children are "mathematicians in the making," educators can leverage pupils' prior experiences and intuitive counting skills. This shift transitions the teacher's role from a "conductor" of performance to a "guide" who facilitates the construction of conceptual understanding, ensuring students can adapt their knowledge to novel challenges (Ncube, & Luneta, 2025).

A cornerstone of this transition is the implementation of CGI and the CPA Approach. CGI prioritizes the teacher's understanding of a child's innate mathematical thinking, allowing students to invent their own strategies for solving complex word problems. When paired with

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the CPA approach, learners navigate mathematical concepts at appropriate complexity levels, moving from physical objects to visual representations and finally to abstract symbols. Recent studies confirm that even the youngest learners can solve a variety of problem types if given the opportunity to model the actions and relationships described in a story, rather than being forced to hunt for "cue words" (Noviyanti, 2020).

The integration of Mother Tongue-Based Multilingual Education (MLE) is critical in ensuring that linguistic barriers do not impede mathematical development. Research indicates that pupils often grasp complex problem-solving schemas more effectively when problems are presented or translated into their first language. This linguistic foundation allows students to articulate their reasoning, manipulate models, and verify solutions with greater confidence. By using the mother tongue, teachers provide a bridge that enables transitional problem solvers to develop full expertise, ensuring that the groundwork laid in primary education supports the sophisticated reasoning skills required in a rapidly changing world (Bacan, 2025; Bularon, 2025).

Ultimately, successful problem-solving requires a synthesis of higher-level thinking skills, including reasoning, communication, and representation. Constructing a mental or physical model of a problem remains the most vital skill for young learners. As evidenced by global standards, such as those found in highly ranked mathematics systems, mastery is achieved when students are encouraged to innovate rather than imitate. By fostering a classroom environment that values invented strategies and conceptual fluency over procedural speed, educators prepare a generation of students capable of higher-order decision-making and logical analysis (NCTM, 2020).

Statement of the Problem

Department of Education encourages teachers to be facilitators of learning and to conduct a student-centered approach within their respective classrooms. Accordingly, the primary intent of this study was to employ the CGI in Mathematics using the CPA Approach to develop problem-solving skills of Grade 2 pupils in a rural school in Bugallon, Pangasinan.

To address the purpose of this study, answers to the following research questions were raised:

1. What are the pupils' performances in problem-solving before, during, and after the instruction in terms of the following?
    a. Comprehension of the word problem
    b. Modeling techniques used by the pupils
    c. Solution strategies used to solve the problem
    d. Accuracy of the solution and answer
2. What is the pupils' development in their conceptual understanding of the four fundamental operations on whole numbers as they explain the solutions to word problems using the CPA Approach?
3. What is the pupils' development in their procedural knowledge of the four fundamental operations on whole numbers as they explain the solutions to word problems using the CPA Approach?

Scope and Delimitations

The study's scope was constrained by its single-school setting and a limited range of CGI problem types assessed, which may affect the generalizability of the findings to other mathematical branches or student populations. Furthermore, the results were interpreted with caution, as the lack of control over participants' varied prior educational backgrounds suggests that individual learning outcomes were significantly influenced by the diverse knowledge and experiences pupils acquired before entering the study.

Review of Related Literature

CGI represents a paradigm shift from teacher-centered lecturing to student-centered facilitation. The core concept of CGI is that children enter school with a rich repertoire of informal mathematical knowledge and intuitive modeling skills. Rather than imposing formal algorithms, CGI encourages teachers to build upon the diverse ways children naturally solve problems. Recent scholarship emphasizes that CGI fosters a classroom environment where mathematical thinking is externalized through discussion, allowing teachers to diagnose student understanding in real-time. By prioritizing "invented strategies" over rote memorization, CGI ensures that students develop a robust number sense that serves as the basis for more complex mathematical reasoning (Moore & Cuevas, 2022; Tazaz & Schoen, 2023).

The CPA Approach, often associated with Singapore Math, provides a developmental scaffold for internalizing mathematical concepts. The main concept involves a three-stage learning process: students begin with "concrete" manipulation of physical objects (e.g., counters or blocks), progress to "pictorial" representations (e.g., drawings or diagrams), and eventually move to the "abstract" level of numerals and symbols. The CPA approach is particularly effective in reducing math anxiety by making intangible concepts tangible. By ensuring that the abstract symbol is firmly rooted in a visual and physical experience, this approach bridges the cognitive gap that often leads to procedural errors in primary learners (Bandahala, 2024; Brown, 2025).

Word Problem Solving remains the ultimate benchmark for mathematical proficiency, as it requires a synthesis of linguistic comprehension and logical calculation. Modern literature identifies word problems as the primary vehicle for developing higher-order thinking skills, including reasoning, communication, and representation. A critical fact established in recent years is that word problems should not be treated as a post-instruction application of a concept; rather, they should be the starting point of instruction to generate mathematical thinking. Studies indicate that when problems are relevant to a pupil's life experiences, their ability to construct a mental model of the problem situation increases, leading to higher accuracy in identifying the appropriate operations (Desiar & Lambinicio, 2024; Suseelan et al., 2022).

The Importance of combining CGI, CPA, and Mother Tongue lies in the elimination of cognitive and linguistic barriers that hinder mathematical development. The integration of Mother Tongue-Based Multilingual Education (MLE) ensures that pupils can process the logic of a word problem in the language they understand best before attempting to model it. When students use their first language to articulate the "concrete" and "pictorial" phases of the CPA approach, they are more likely to successfully transition to "abstract" mathematical sentences. This combination allows for a "low-floor, high-ceiling" learning environment where students of varying abilities can engage with the same task using strategies that are meaningful to them, thereby fostering both conceptual and procedural mastery (Bacan, 2025; Janaban, 2025).

Ultimately, the synthesis of these four elements—CGI, CPA, Word Problem Solving, and Mother Tongue—creates a holistic pedagogical framework. By reversing the traditional curriculum flow to start with linguistic and physical exploration, educators can ensure that the mathematical groundwork laid in early childhood is durable and adaptable. This comprehensive approach shifts the focus from "desired performance" (getting the right answer) to "true understanding" (knowing why the answer is right). As primary education evolves, this integrated model is becoming the global standard for producing mathematically literate citizens

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capable of navigating an increasingly complex world (Kurniawan et al., 2021; Pillos et al., 2020).

Theoretical Framework

CGI is an educational framework that prioritizes the teacher's understanding of a child's internal mathematical logic. Unlike traditional models that mandate specific algorithms, CGI focuses on how students naturally model the actions and relationships described in word problems. The framework identifies specific problem types—such as Join, Separate, Part-Part-Whole, and Comparison—and categorizes student responses based on their developmental sophistication. By using students' self-generated strategies as a guide, educators can facilitate a deeper conceptual transition from concrete counting to abstract reasoning without imposing rigid procedural rules (Ramaila, 2025; Sahin et. al., 2020).

Regarding Primary Addition and Subtraction Strategies, CGI research identifies a progression starting with Direct Modeling. At this stage, children use physical objects or drawings to represent every quantity in a problem (e.g., physically "joining" two sets of blocks). As their number sense matures, they transition to Counting Strategies, such as "counting on" from a larger number or "counting back." Eventually, students reach the Derived Facts stage, where they leverage known mathematical relationships (like doubles or "making ten") to solve problems mentally. This progression demonstrates a natural shift from physical representation to internal numerical fluency (Becker, 2021; Powell et al., 2023).

For Primary Multiplication and Division Strategies, CGI emphasizes the child's ability to visualize "groups of" items. Initial strategies often involve Grouping and Partitioning, where students physically arrange objects into equal sets to represent multiplication or "fair sharing" (partitive division). As students gain confidence, they move toward Measurement Division strategies, where they repeatedly subtract or group a specific quantity until the total is exhausted. These intuitive methods allow students to grasp the conceptual relationship between repeated addition/subtraction and multiplication/division before they are introduced to formal operation symbols (Becker, 2021; Powell et al., 2023).

As students encounter larger numbers, they develop Multidigit Strategies that reflect a deeper understanding of place value. Rather than following a standard vertical algorithm, CGI students often use Base-Ten Modeling, where they represent tens and ones separately using physical or mental constructs. Common strategies include "Incrementing" (adding or subtracting by tens and then ones) and "Combining Tens and Ones" (splitting both numbers by place value and adding the components). This flexible use of numbers ensures that students maintain a sense of quantity and "number magnitude," preventing the common procedural errors associated with rote memorization of "carrying" or "borrowing" (Becker, 2021; Powell et al., 2023).

Ultimately, the CGI framework demonstrates that primary students are capable of solving a wide array of complex problems when given the autonomy to use their own strategic logic. By integrating these strategies with the CPA approach, teachers can ensure that students' mathematical thinking remains grounded in physical reality even as it evolves into abstract calculation. This student-centered trajectory not only improves accuracy but also builds a lasting conceptual foundation that prepares learners for secondary-level mathematics (Bermejo et al., 2021; Taha et al., 2025).

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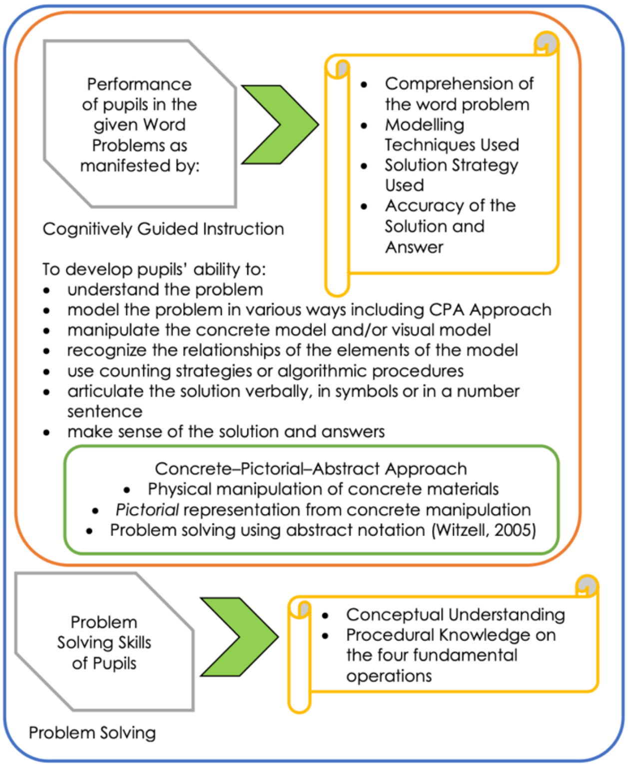
Conceptual Framework

Figure 1

CGI using the CPA Approach



METHODOLOGY

This mixed-methods research study employed CGI in Mathematics using the CPA Approach to develop problem-solving skills among Grade 2 pupils in a rural school in Bugallon, Pangasinan.

Research Design

This study employed a mixed-methods research design to synthesize qualitative and quantitative data, facilitating a holistic evaluation of the developmental trajectory of students' mathematical proficiency. The qualitative component utilized naturalistic inquiry—incorporating student verbalizations, structured interviews, and peer-validated classroom observations—to capture the nuance of pupils' internal cognitive modeling and emergent problem-solving strategies. These narrative insights were integrated with quantitative descriptive statistics, including frequency distributions and percentage averages from serial Mathematics Problem Solving Assessments, to objectively measure the efficacy of the instructional intervention. To uphold the standards of trustworthiness and methodological rigor, the researcher implemented data triangulation across three assessment phases (pre-, mid- and post-intervention), ensuring a credible and multidimensional analysis of the pupils' transition from concrete to abstract reasoning (Cano & Lomibao, 2023).

Research Steps

The study followed a structured five-stage action research design aimed at integrating CGI and the CPA Approach into the primary mathematics curriculum. The process commenced with the Preparation of Materials, where lesson plans and instructional media were aligned with

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CGI problem types, followed by the Construction and Validation of assessment tools and classroom observation instruments. Criteria for data analysis were then established to ensure that gathered metrics could accurately describe the pupils' problem-solving trajectories. During the Implementation Stage, the module was delivered alongside a series of assessments—administered before, during, and after instruction—supplemented by expert classroom evaluations from three external resource personnel. Finally, the Data Analysis phase utilized a mixed-methods approach, employing descriptive statistics to quantify student progress and qualitative analysis of student interviews to provide a comprehensive profile of how CGI and CPA methodologies fostered enhanced mathematical reasoning.

Data Collection and Sample Selection

The study utilized a specific participant pool of 15 Grade 2 pupils (7 females and 8 males) from a rural school in Bugallon, Pangasinan, following the exclusion of one student due to chronic absenteeism. Conducted by the researcher-teacher over a one-month period in the 2019–2020 academic year, the methodology integrated an hour of daily "Advanced Math Class" sessions characterized by the CPA Approach and CGI principles. The research process involved a rigorous data collection sequence, including pre-, mid-, and post-instruction Mathematics Problem Solving Assessments, alongside qualitative artifacts and interviews with a subset of seven pupils to track conceptual growth. Triangulation was further supported by the evaluations of three external resource personnel who observed the classroom implementation, ensuring that the transition from the pupils' initial informal strategies to more sophisticated problem-solving skills was accurately documented and analyzed through both descriptive statistics and qualitative inquiry.

Data Analysis Methods

This study employed a rigorous mixed-methods analysis to evaluate the problem-solving performances of Grade 2 pupils across three phases—before, during, and after instruction—focusing on comprehension, modeling techniques, solution strategies, and accuracy. The qualitative component utilized triangulation of pupil assessments, interview transcripts, and observation notes to generate categories for modeling and strategy use, while simultaneously assessing procedural mathematics understanding through pupils' verbal and written explanations of the four fundamental operations. Quantitative data tracked student progress via frequency distributions of comprehension levels (classified as Above Average, Average, or Below Average) and success rates in the Mathematics Problem Solving Assessments. To ensure linguistic validity and support Mother Tongue-Based instruction, a panel of three external personnel performed cross-translations of assessments between English, Filipino, and Pangasinense. Furthermore, the instructional implementation was validated through classroom evaluations by external resource personnel, whose feedback on teacher strategies and localized materials informed immediate interventions, ultimately providing a comprehensive profile of the pupils' transition from basic procedural knowledge to sophisticated, self-generated conceptual modeling.

Study Limitations and Ethical Considerations

To uphold the methodological integrity and credibility of this mixed-methods inquiry, the researcher replaced traditional validity metrics with the contemporary standards of dependability, transferability, and confirmability. Trustworthiness was established through a robust triangulation of data, integrating longitudinal assessments, student-generated artifacts, and systematic observation notes to construct a comprehensive profile of mathematical development. To further minimize researcher bias, member checking was utilized, allowing

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participants to validate the accuracy of transcribed responses. Transparency was maintained via a rigorous researcher audit trail, documenting all procedural decisions from intervention through analysis. Finally, the study adhered to strict ethical protocols and data management, ensuring participant confidentiality through the use of pseudonyms and secure, time-limited storage of identifiable records, thereby ensuring that findings are both ethically grounded and scientifically robust.

RESULTS AND DISCUSSION

SOP 1. What are the pupils' performances in problem-solving before, during, and after the instruction in terms of the following?

a. Comprehension of the word problem

To describe and evaluate the comprehension skills of the Grade 2 participants, this study employed a frequency-based classification system—categorizing pupils as Above Average, Average, or Below Average—based on their ability to understand problems and manifest unique modeling techniques across three assessment phases. Findings indicated satisfactory overall performance, with 12 pupils achieving an Above Average rating and 3 achieving an Average rating, demonstrating that the integration of CGI and the CPA approach fosters deep conceptual understanding. While remediation was required for some pupils due to inconsistent attendance or a persistent reliance on traditional, non-modeling methods, the use of the pupils' mother tongue significantly minimized the need for teacher assistance. Notably, even students with prolonged absences were able to comprehend problems immediately upon their return, confirming that these student-centered strategies allow learners to internalize mathematical logic effectively, even when they initially struggle to externalize their solutions through formal modeling.

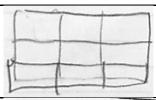
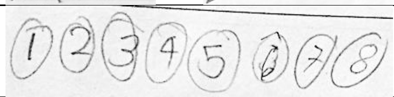
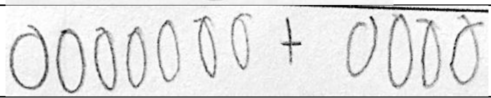
b. Modeling techniques used by the pupils

The study findings indicate a significant shift in pupils' problem-solving approaches, moving from a rigid reliance on rote number sentences to diverse, intuitive modeling techniques. Prior to the intervention, students exhibited confusion and high error rates because traditional instruction introduced abstract concepts before problem-solving, stifling their innate creativity. By reversing this flow and using word problems to introduce the four fundamental operations, the study observed a substantial improvement: post-instruction data showed 100 correct responses out of 120, characterized by ten distinct modeling variations. These included the use of pictorial models, tallying, skip counting, and the integration of numerals with number sentences. This progression from concrete to pictorial to abstract levels confirms that allowing students to invent their own strategies—rather than imposing formal algorithms—leads to a more robust conceptual and procedural understanding of mathematics.

There were 10 different modeling techniques made by the pupils based on their own interpretation of the given problem:

Table 1

Modeling Techniques on Addition and Subtraction

Models/Pictures	 
Models with Numerals	
Models with Symbols	

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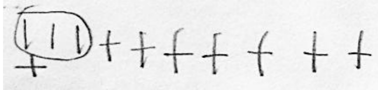
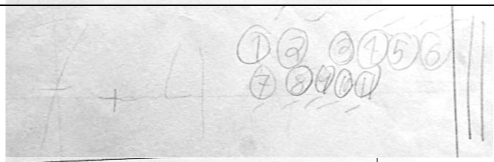
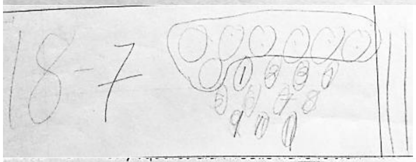
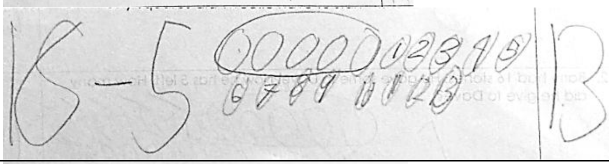
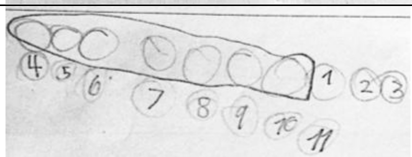
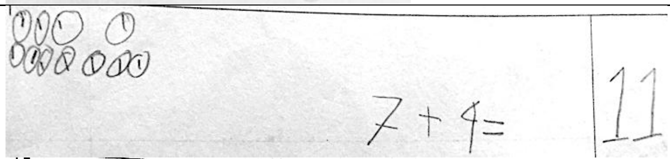
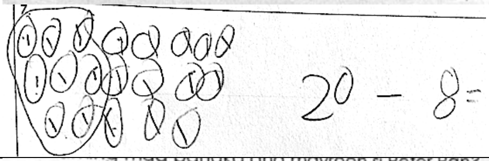
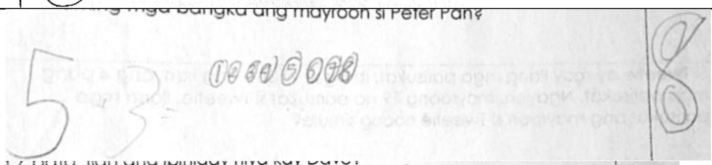
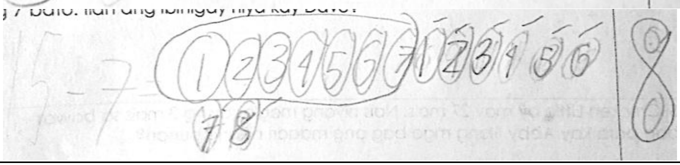
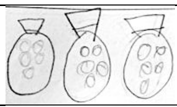
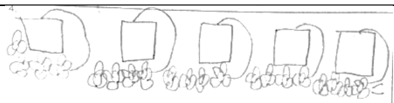
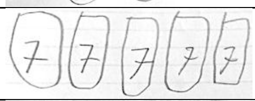
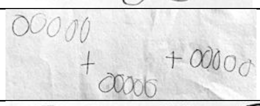
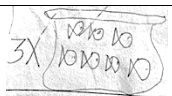
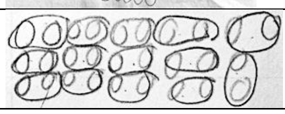
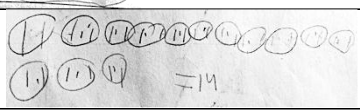
Models with Counting/Tallying	
Models with Numerals and Symbols	  
Models with Numerals and Counting/Tallying	
Models with Counting/Tallying and Number Sentence	 
Models with Numerals, Counting/Tallying, and Number Sentence	 

Table 2

Modeling Techniques on Multiplication and Division

Models/Pictures	 
Models with Numerals	
Models with Symbols	 
Models with Counting/Tallying	 

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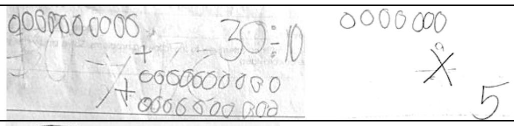
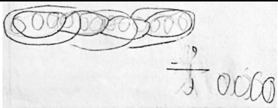
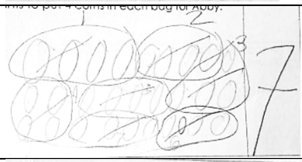
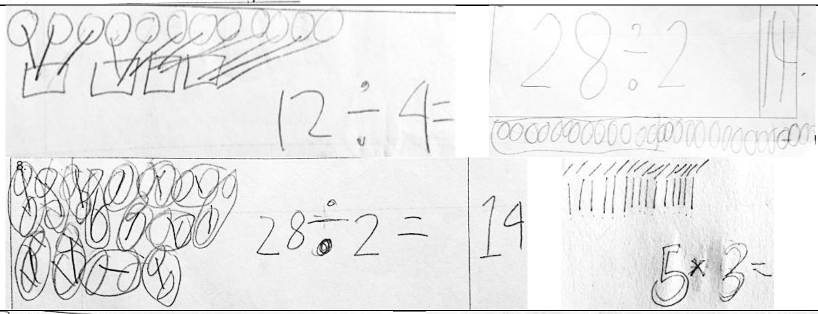
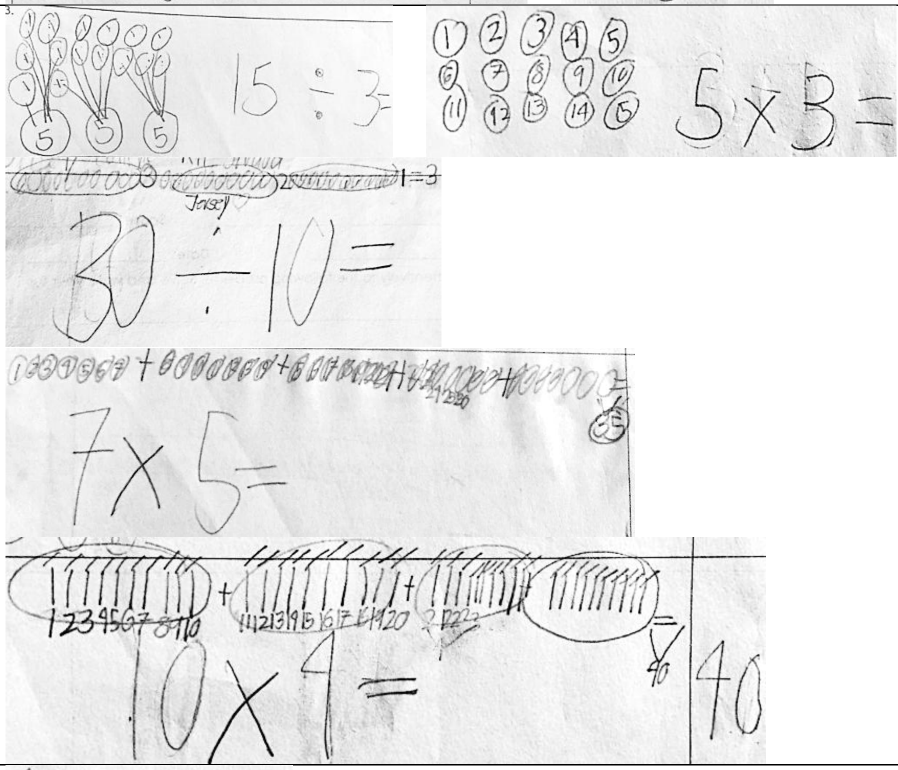
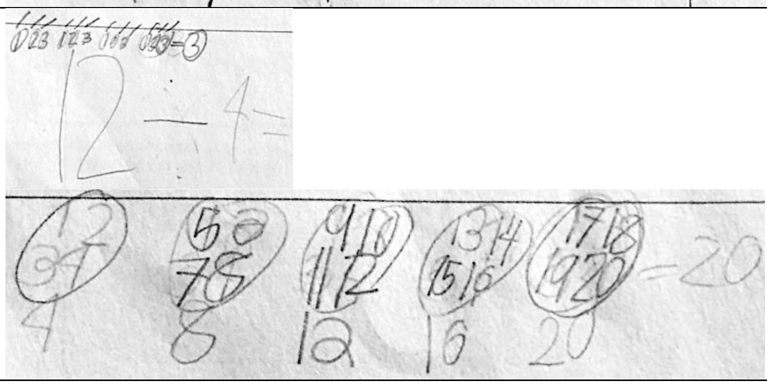
Models with Numerals and Symbols	
Models with Symbols and Counting/Tallying	
Models with Numerals and Counting/Tallying	
Models with Counting/Tallying and Number Sentence	
Models with Numerals, Counting/Tallying, and Number Sentence	
Models with Numerals, Counting/Tallying, Number Sentence, and Skip Counting	

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c. Solution strategies used to solve the problem

The study utilized frequency distribution analysis to evaluate and describe the evolution of solution strategies employed by Grade 2 pupils across three distinct instructional phases—before, during, and after the intervention. By recording the frequency of specific strategies used in correct responses within the Mathematics Problem Solving Assessments, the researcher was able to quantitatively track the transition from rudimentary or rote methods to more sophisticated, student-generated strategies. This systematic documentation, categorized in the study, serves as a primary evidence base for determining the effectiveness of the instruction in shifting pupils toward higher-level mathematical reasoning and conceptual fluency.

There were 7 different solution strategies made by the pupils based on their own interpretation of the given problem:

Table 3

Solution Strategies on Addition and Subtraction

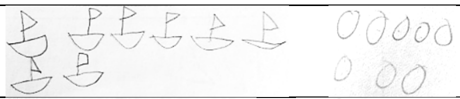
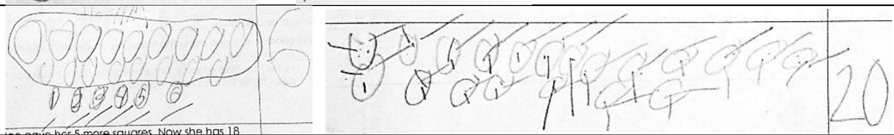
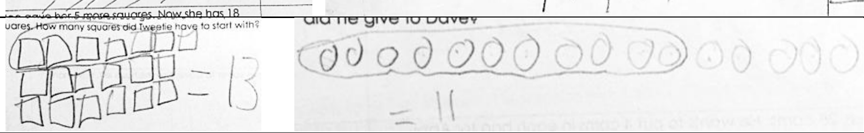
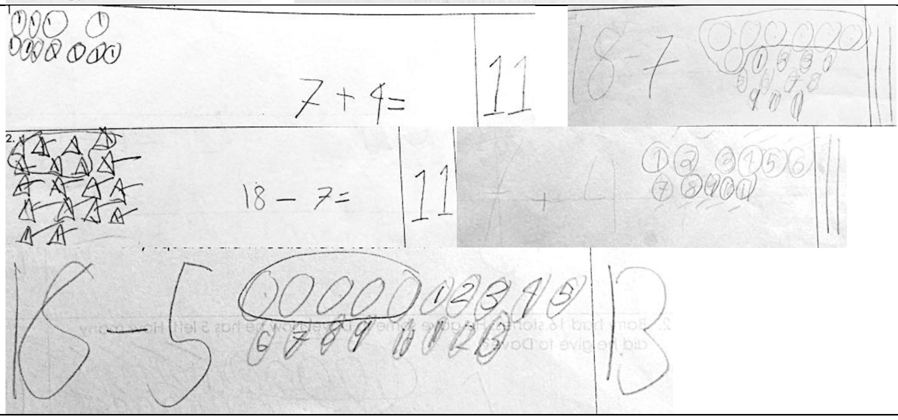
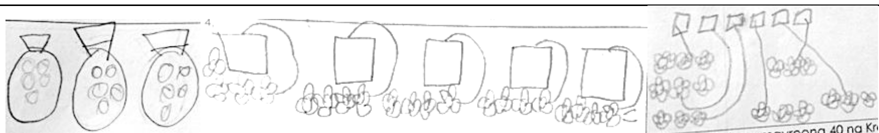
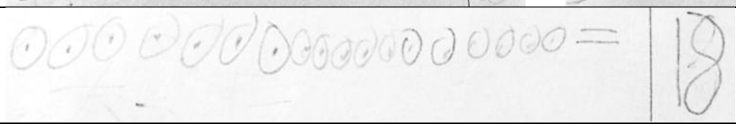
Direct Modeling	
Invented Algorithm	
Direct Modeling with Counting	
Direct Modeling with Derived Facts or Recall	
Direct Modeling with Counting and an Invented Algorithm	

Table 4

Solution Strategies on Multiplication and Division

Direct Modeling	
Invented Algorithm	
Direct Modeling with Counting	

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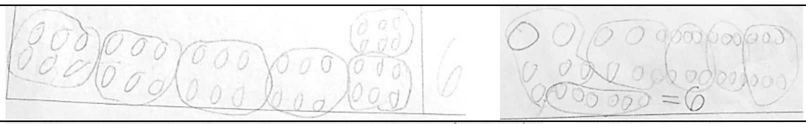
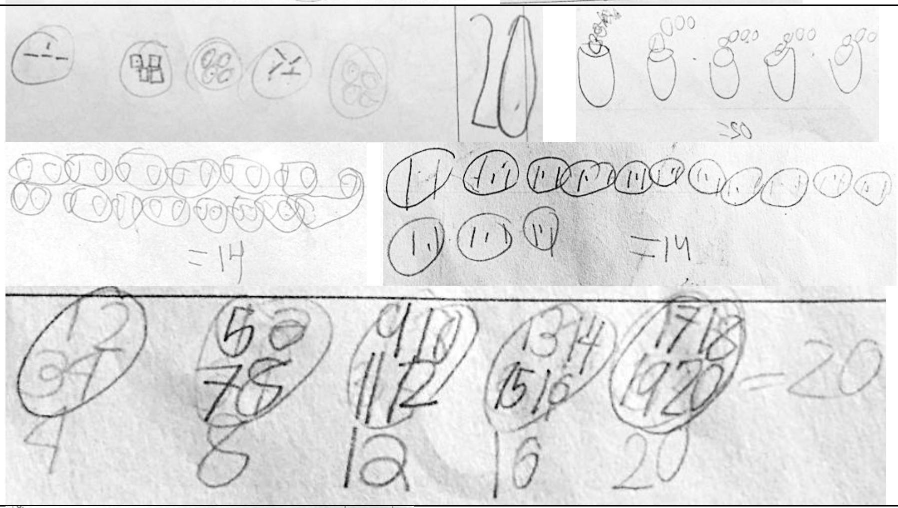
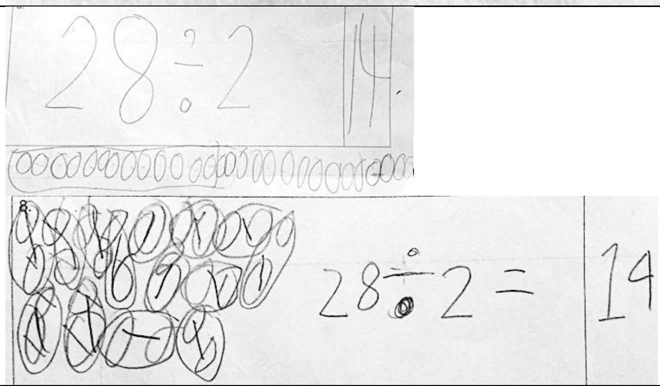
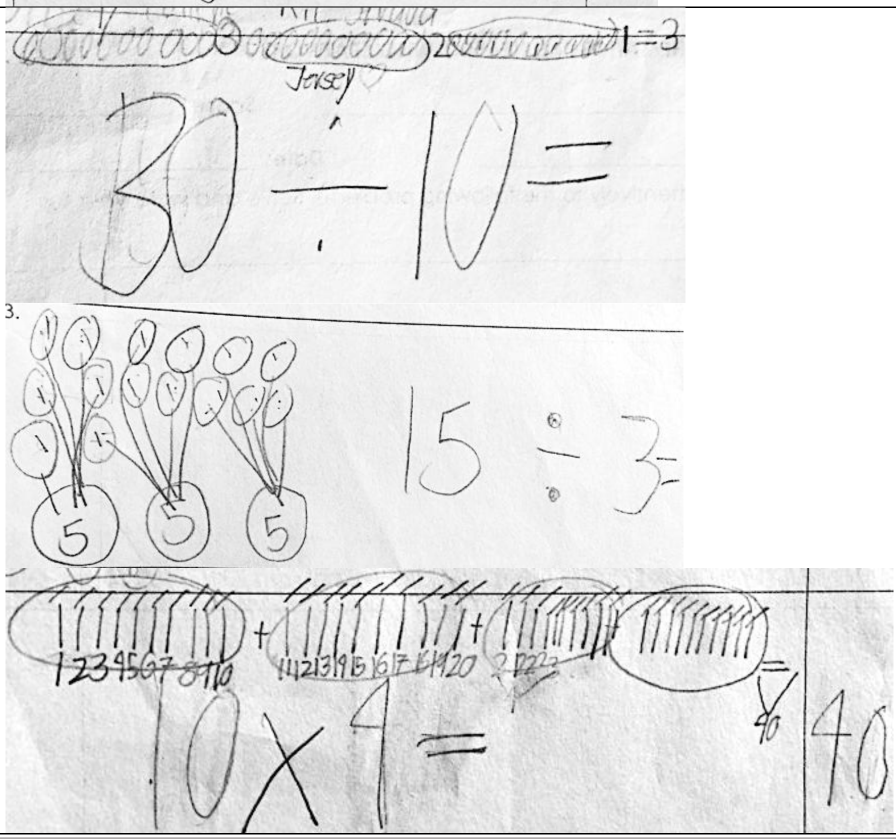
Direct Modeling with Derived Facts or Recall	
Direct Modeling with Counting and Derived Facts or Recall	
Direct Modeling with Counting and an Invented Algorithm	
Direct Modeling with Counting, Derived Facts, or Recall and Invented Algorithm	

EduHeart Knowledge Network and Publishing, Inc.

Asian Research Journal of Education, 2025
E-ISSN: 3028-0842
P-ISSN: 3028-0834
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DOI: https://doi.org/10.66206/eduheart.2026.298

d. Accuracy of the solution and answer

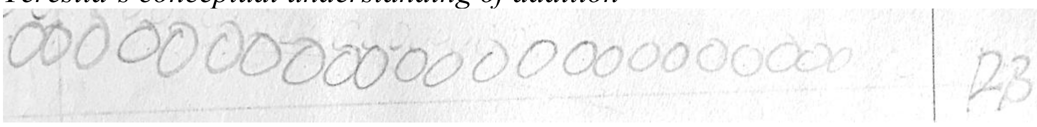
The study evaluated the level of accuracy in pupils' mathematical solutions by tracking the frequency of correct answers across pre-, mid-, and post-instruction assessments. While a small subset of students (e.g., Pablo and Jose) demonstrated high proficiency prior to the intervention, the majority of the class, including students like Mario and Manuel, showed significant performance gains as a result of the CPA approach. Final assessments revealed that 12 out of 15 pupils achieved high scores (between 6 and 8), with the remaining three students also showing marked improvement. These results, supported by observations from external evaluators, suggest that the increased accuracy was largely driven by higher student engagement and the intuitive nature of the CPA tasks, which allowed even struggling learners to refine their problem-solving capabilities over the course of the study.

SOP 2. What is the pupils' development in their conceptual understanding of the four fundamental operations on whole numbers as they explain the solutions to word problems using the CPA Approach?

The midpoint of the instructional intervention revealed a significant emergence of student agency, as pupils began to voluntarily demonstrate and articulate their innate mathematical reasoning to the class. A key observation was that, after only two weeks of exposure to the CGI and CPA framework, students successfully transitioned from passive learning to actively explaining their own unique modeling techniques and solution strategies. This development proves that when students are given the autonomy to interpret word problems through their own illustrations and drawings, they move beyond rote imitation to a deeper, self-constructed conceptual understanding of mathematical operations tailored to their individual interpretative styles.

Figure 2

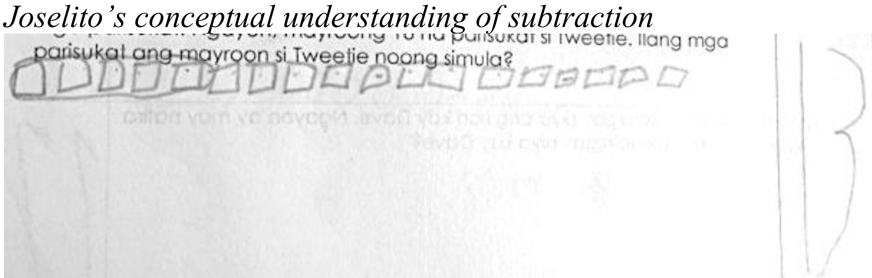
Teresita's conceptual understanding of addition



Teresita drew 4 circles, then added 19 circles. She then counted all of the circles and got the correct answer. Figure 35 shows how she illustrated her solution. It was a challenge for the researcher to persuade Teresita to use illustrations because she insisted on using the traditional mathematical sentence in answering a word problem. Luckily, she listened and got the correct answer. Pablo, Manuel, and Claudia did what Teresita had done as well. This shows the development of Teresita's problem-solving skills.

Figure 3

Joselito's conceptual understanding of subtraction



Joselito drew 18 squares, then he encircled 5 squares. He counted the remaining squares and got the answer. Figure 36 shows his illustrations and answers. Together with Joselito's way of answering, the following pupils did the same: Elisea, Manuel, and Peping. This shows the development of Joselito's problem-solving skills.

EduHeart Knowledge Network and Publishing, Inc.
Asian Research Journal of Education, 2026
E-ISSN: 3028-0842
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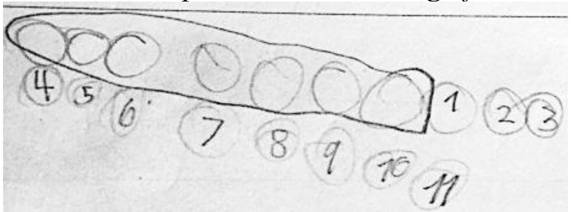
Figure 4

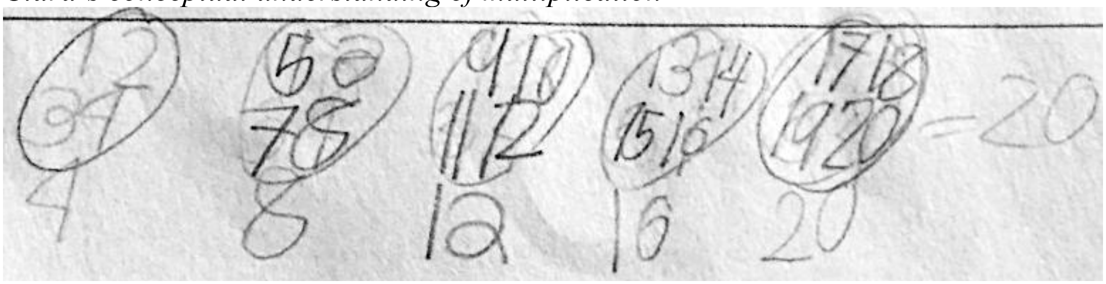
Pablo's conceptual understanding of subtraction



Pablo drew first the number 18 stones as circles. Then, he encircled the 7 circles that were left. He counted the remaining circles and wrote the corresponding number in each circle; thus, he got the correct answer. Figure 37 shows how he solved the problem. Mamerto and Jose did the same with Joselito's way of solving. This shows the development of Pablo's problem-solving skills.

Figure 5

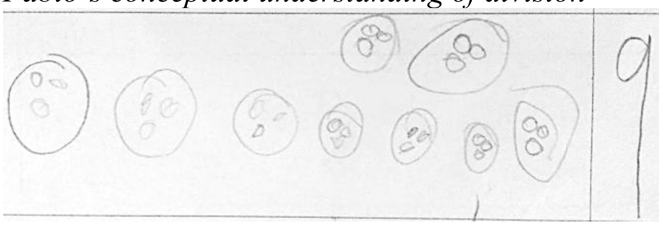
Clara's conceptual understanding of multiplication



Clara counted the first four flowers in a pot by writing 1, 2, 3, and 4 in a circle. Then, she added more numbers by fours in each circle, making 5, 6, 7, and 8 in another circle. This cycle continued until Clara reached the number 20. Clara didn't know she was already doing skip counting. She just answered what she knew and understood. This shows the development of Clara's problem-solving skills.

Figure 6

Pablo's conceptual understanding of division



Pablo drew 3 small circles and enclosed them in a big circle, and repeated this for the eighth time, so that all small circles were 27. He counted all of the big circles and got the correct answer. Figure 39 shows his illustrations and answer. Mamerto did the same thing Pablo did to solve the given word problem.

SOP 3. What is the pupils' development in their procedural knowledge of the four fundamental operations on whole numbers as they explain the solutions to word problems using the CPA Approach?

A pivotal turning point in the study occurred after two weeks of implementation, when pupils transitioned from passive learners to active demonstrators of their own mathematical reasoning. By voluntarily sharing their solutions with the class, the Grade 2 pupils demonstrated a sophisticated ability to articulate the logic behind their personalized drawings

Asian Research Journal of Education, 2025
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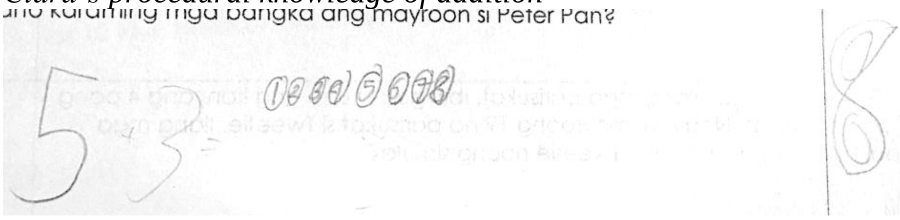
and illustrations. This evidence confirms that the CGI and CPA Approach empowered students to move beyond rote imitation, allowing them to construct and explain unique modeling techniques and solution strategies rooted in their individual interpretations of the word problems. This self-directed externalization of mathematical thought provides a qualitative benchmark for the development of both conceptual fluency and communicative confidence in young learners.

Figure 7

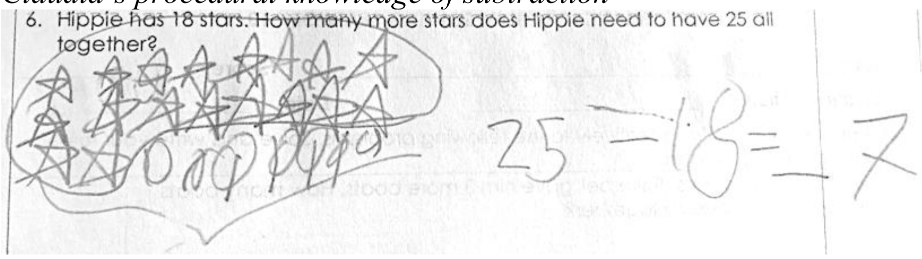
Clara's procedural knowledge of addition



Clara was a new student in the rural school. She worked independently on every assessment. When I had group work, she participated well with her groupmates. She was trying to cope with her shyness, but still she participated well during the class. Figure 40 shows her combination of modeling techniques and solution strategies used. She drew the circles first according to how it was stated in the problem, then she counted all of them. Thus, she wrote the number sentence correctly. This shows the development of Clara's problem-solving skills.

Figure 8

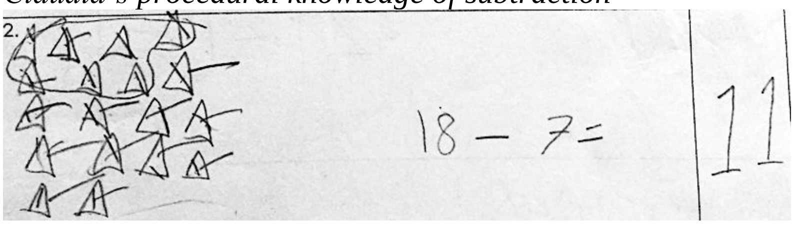
Claudia's procedural knowledge of subtraction



After two weeks of implementing the principle and approach, Claudia was one of the pupils who tried and used the different modelling technique and solution strategies in answering word problems. Figure 41 shows how she answered the problem. First, she drew 18 stars, then drew circles to complete the 25 stars needed. She encircled the circles and got the correct answer. She also used the correct number sentence. This shows the development of Claudia's problem-solving skills.

Figure 9

Claudia's procedural knowledge of subtraction



Claudia drew 18 triangles to represent the number of stones, then she encircled 7 stones to indicate what was left. She counted the remaining triangles by checking them one by one. She also wrote the correct number sentence with the correct answer. Figure 42 shows how she answered the problem. This shows the development of Claudia's problem-solving skills.

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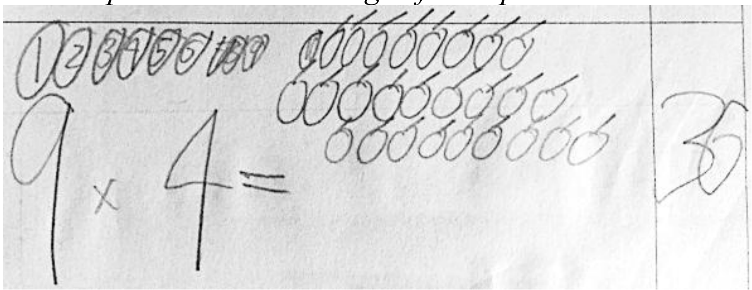
Figure 10

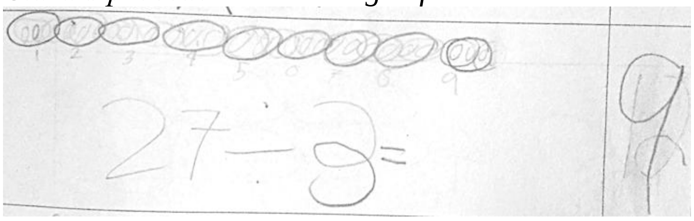
Clara's procedural knowledge of multiplication



Clara illustrated the 9 circles by indicating the numerals in each circle, then she drew another 9 circles for 3 times. She counted all of the circles and got the correct answer with the correct number sentence. Figure 43 shows her solution. This shows the development of Clara's problem-solving skills.

Figure 11

Clara's procedural knowledge of division



Clara drew 27 circles and then grouped them by 3. She counted all the big circles and got the correct answer. She also wrote the correct number sentence. Figure 44 shows her illustrations and solution. This shows the development of Clara's problem-solving skills.

SUMMARY

This descriptive action research investigated the enhancement of problem-solving skills among 15 Grade 2 pupils in a rural school by integrating the overarching principles of CGI with the CPA Approach. Over a one-month period, the study utilized a mixed-methods design—incorporating trilingual assessments (English and Filipino), interviews, and observations—to track student development across three instructional phases. The findings revealed a significant positive impact, with approximately 80% of pupils demonstrating a transition from rote memorization to intuitive, self-generated modeling techniques and solution strategies, such as combining skip counting with numeral modeling. Ultimately, the intervention fostered a deeper conceptual and procedural mastery of the four fundamental operations, as students successfully leveraged concrete objects and pictorial representations to navigate complex word problems while developing more positive attitudes toward mathematical inquiry.

CONCLUSIONS

This study establishes the definitive effectiveness of integrating CGI with the CPA Approach to cultivate both procedural and conceptual mastery of the four fundamental operations. The study demonstrates that by initiating instruction with culturally relevant word problems, educators can successfully leverage pupils' innate mathematical intuition and prior experiences. Findings reveal that when students are permitted to utilize meaningful, self-selected strategies—such as grouping, tallying, and skip counting—they naturally progress from utilizing physical objects and pictorial illustrations to sophisticated abstract levels

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involving numerals and formal number sentences. Ultimately, the evidence suggests that this learner-centered trajectory not only facilitates a deeper understanding of addition, subtraction, multiplication, and division but also bridges the gap between informal modeling and formal mathematical representation.

RECOMMENDATIONS

The study recommends the use of CGI using the CPA approach in the teaching of the four fundamental operations. This may imply reversing the flow of the existing K–3 Number and Number Sense Curriculum, which is as follows:

1. Explain the different meanings of the four basic operations of whole numbers.
2. Use and give the relationship among the four basic operations of whole numbers.
3. Use the operation(s) appropriate to a given situation.
4. Apply the properties of addition and multiplication.

This study recommends that instruction starts with the application, not only of addition and multiplication, but of the four fundamental operations to word problems, allowing pupils to employ their own strategies. Eventually, they will make sense of the strategies they use and get the essence of the meanings of the basic operations of whole numbers. They will understand the relationships of the four basic operations of whole numbers as they solve the problems using their invented strategies. They need not be told that certain problems are addition, subtraction, multiplication, or division problems because it is clear to them how all these operations are related. Consequently, they will reach the level of abstraction and understand the four fundamental operations procedurally and conceptually. The numerals in the number sentences that they write are clear and meaningful to them.

ACKNOWLEDGMENTS

The researcher reflects on the thesis journey as an intense yet fulfilling process that has significantly enhanced her professional pedagogical skills, primarily through the collaborative support of a dedicated academic and personal network. Central to this achievement was the guidance of Dr. Auxencia A. Limjap, whose expertise in mathematics education and constructivist learning was instrumental in shaping the study's vision, alongside the mentorship of Dr. Minie Rose C. Lapinid, who provided essential academic counsel. The researcher also highlights the vital role of peer collaboration during rigorous study periods and the unconditional emotional and moral support provided by family members. Ultimately, the successful completion of this work is attributed to a combination of professional mentorship, communal encouragement, and a strong spiritual foundation, all of which provided the resilience and clarity needed to navigate the complexities of advanced educational research.

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