The Seybold Report

ISSN 1533-9211

DOI: 10.5281/zenodo.14196636

INVESTIGATING THE IMPACT OF THE CONCRETE-PICTORIAL-ABSTRACT APPROACH ON STUDENTS' LEVEL OF CONCEPTUAL UNDERSTANDING, PROBLEM-SOLVING SKILLS AND PERFORMANCE

CLAIRE EVELYN V. CEDO [1], WENCESLAO A. CORONADO [2], FLORDELINE A. CADELIÑA [3], AILEEN JOYCE J. LIM [4] and ANA WINNIELYN J. GALEOS [5]

[1] Mindanao State University-University Training Center, Marawi City, Lanao Del Sur, Philippines.
[2,3,4,5] Mindanao State University at Naawan, Naawan, Misamis Oriental, Philippines.
Email: [1]claireevelyn79@gmail.com, [2]wenceslao.coronado@msunaawan.edu.ph, [3]flordeline.cadelina@msunaawan.edu.ph, [4]aileenjoyce.lim@msunaawan.edu.ph, [5]anawinnielyn.galeos@msunaawan.edu.ph

Abstract

This study investigated the impacts of the Concrete-Pictorial-Abstract (CPA) teaching method on the level of comprehension and performance in the geometry of the grade seven students of the Mindanao State University-University Training Center, academic year 2023-2024. The researcher employed a one-sample pretest-posttest design among the respondents to measure the variables before and after applying the technique in teaching Mathematics. The results clearly showed that there was a significant improvement in their performances. Moreover, the respondents also specified the CPA approach with positive reviews, stating that it increased their confidence and enhanced their understanding of geometry, which may lead to better performance in Mathematics class. Therefore, the CPA technique is a successful strategy for raising math proficiency and learning; both the learners and mathematics teachers may gain substantial benefits.

Keywords: CPA Progression System, CPA Framework, CPA Instructional Sequence.

INTRODUCTION

Studying is an ongoing process that involves learning new information, abilities, and encounters. According to Bandura (1977), passionate pursuit and focused attention are necessary for learning. It is a bilateral process that typically occurs inside the confines of a rectangular room. With this method, the teacher and the student communicate directly. Moreover, learning is a reciprocal experience between individuals; it is a dialogue, not a monologue," asserted Vygotsky in 1978. This highlights how important communication and teamwork are to the learning process.

With the frequent use of varied instructional strategies that support learning and involve students and particular needs, mathematics teachers should prioritize helping students enhance their numeracy skills. Numeracy skills include a person's ability to understand and work with numbers, including basic arithmetic operations, data analysis, metrics, and mathematical concepts (Geary et al., 2019). It includes the capacity to use numerical data, evaluate

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

mathematical patterns, and apply mathematical reasoning to various real-world situations.

However, in the Philippine context, numeracy abilities are frequently thought to be lacking. According to the Department of Education (DepEd), the Philippines' dismal score on the 2022 Program for International Student Assessment (PISA) indicates that children in the nation need to catch up regarding their learning competencies. The Philippines ranked 10th out of 81 countries in terms of average math scores according to the 2022 Program for International Student Assessment (PISA), which compares the skills and knowledge of 15-year-old students in various countries (philstar.com). In the PISA 2022, Filipino students' mean math performance was much lower than that of students from other countries. According to the poll, there is a significant achievement gap in the Philippines, with a sizable percentage of students performing at or below the minimal proficiency criterion in numeracy skills. Research on lower-middle-income economies, including the Philippines, has been very scant (Haw & King, 2023).

During the teaching and learning process, educators use a variety of strategies and tactics to close this gap, especially related to the level of competency in numeracy skills (Aguhayon et al., 2023). One of these tactics is the Concrete-Pictorial-Abstract (CPA) method. The introduction of the CPA program into the Philippine educational system aims to promote and develop a deep understanding of mathematical ideas. It offers a systematic process that progressively allows students to transition from tangible experiences to conceptual reasoning.

The CPA method is a widely recognized instructional approach in mathematics education that seeks to enhance students' comprehension of mathematical ideas by using a sequence of tangible elements, visual representations, and symbolic abstractions (Agustin, 2023). Although dedicated studies may focus on something other than applying CPA in the Philippines, this instructional approach has been extensively utilized and researched globally and within the context of Filipino students. The premise is that pupils achieve optimal learning outcomes when they can establish connections between abstract concepts and tangible experiences and visual depictions (Salami et al., 2020). Visual representations can clarify intricate concepts and enhance the accessibility of knowledge to a broader range of people. By combining tangible images and symbolic representations, a concrete, pictorial abstract with references can efficiently convey essential concepts and substantiate them with evidence from credible sources (Nair et al., 2020).

Moreover, the CPA technique can also benefit pupils with learning challenges or unique educational needs. Commencing with tangible elements and progressively transitioning to more conceptual representations offers a framework that assists students with varying learning styles and capacities (Bruner, 1966). This guarantees that the educational process is comprehensive and accommodates the requirements of all students. The source of this information is the Singapore Ministry of Education, specifically from 2012.

The CPA approach consists of three stages: (a) the concrete stage refers to the phase in which physical items or manipulations are utilized to express mathematical concepts. Students are encouraged to engage in tactile exploration and manipulating items to develop a tangible

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

comprehension of the taught idea. (b) In the pictorial stage, children go from using tangible items to utilizing visual representations. They employ visual aids like drawings, diagrams, or photographs to depict the mathematical notion. This facilitates their progression from the tangible phase to the conceptual phase. (c) Lastly, the abstract level uses numerical values, symbols, and mathematical equations to symbolize mathematical ideas. A CPA (Concrete-Pictorial-Abstract) strategy enables youngsters to comprehend new concepts by leveraging their pre-existing knowledge and experiences, offering them a more recognizable and practical starting point for acquiring new knowledge (Athienitis, 2022).

This study examined how the CPA approach affected students' conceptual understanding and problem-solving. It evaluated students' problem-solving abilities, compared their scores on the pretest and posttest, determined any correlation between perception and abilities, and studied how they perceived the CPA approach. The results of this study would add to the body of knowledge already available on the subject of teaching mathematics.

This study aimed to investigate the impact of the Concrete-Pictorial-Abstract sequence of instructions and its significance on the mathematical performance of the students in terms of conceptual understanding, problem-solving skills, and performance, specifically in seeking to answer the following:

1. What is the student's performance level in geometry in terms of:
   1.1 Achievement Test
   1.2 Problem-solving
2. What is the student’s perception of the CPA approach to learning geometry?
3. Is there a significant difference in students’ performance in geometry before and after the CPA approach as measured by:
   3.1 Achievement Test
   3.2 Problem-solving

METHODOLOGY

A. Research Design

In this study, the researcher employed a one-sample pretest-posttest design. This design is a methodological approach wherein a single cohort of participants is evaluated on a specific variable both before and following an intervention or treatment. The group is measured on the variable of interest to establish an initial baseline. The participants completed a pre-assessment exam utilizing the Geometry Assessment Test, which consists of 35 items. Subsequently, the participants take an achievement test and problem-solving assessments. The outcomes of the pre-assessment tests are then analyzed. Based on the diagram, the blue arrow signifies the result of the pre-test assessment before administering the intervention method, in which the participants have not encountered the CPA teaching strategy. The next phase involved the application of an intervention teaching strategy known as the concrete pictorial abstract (CPA).

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

After applying the CPA intervention teaching method, the same participants are reassessed using the identical variable/assessment tests administered before the use of the teaching strategy.

During the post-assessment phase, the participants will complete a series of evaluations, including the Geometry Assessment Test, problem-solving, and formative tests. Additionally, a feedback survey questionnaire regarding the impact of CPA on mathematics teaching will be distributed following all performance tests to gather insights into the participants' perceptions of the CPA approach. This design enables the researchers to closely monitor any changes resulting from the intervention since each participant acts as the control variable.

As shown by the diagram, the black arrow signifies the concrete changes in student performance after the CPA teaching strategy has been administered. By contrasting the results from the pretest and posttest, the design helps ascertain whether the intervention had a significant impact on the variable being examined.

Figure 1 shows the design paradigm:

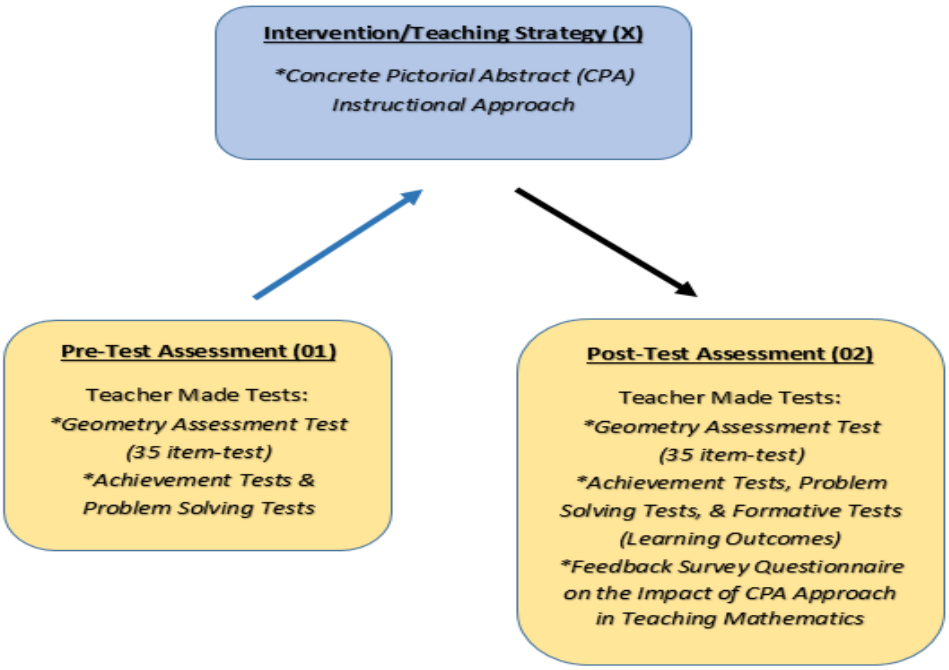

Figure 1: Design Paradigm of the Study

Where:

O1 refers to the pretest of the student's achievement test and problem-solving skills

X refers to treatment (Concrete pictorial Abstract)

O2 refers to the posttest given after the treatment

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

Qualitative data support this research. Focus groups and student interviews were part of the qualitative process. It enabled investigation and thorough examination of the impact of CPA on students' performance in geometry, conceptual understanding, and problem-solving abilities.

B. Participants of the Study

The study focused on a Grade 7 class at MSU-University Training Center for the 2023-2024 school year. This class, composed of 50 students, was taught geometry using the Concrete-Pictorial-Abstract (CPA) approach.

The teaching method involved three stages: first, the students explored geometric concepts with real objects, which allowed them to interact with the material physically.

Next, they drew pictures of these objects to express their learning. Finally, they moved on to using symbols to represent geometric ideas. This gradual approach, moving from hands-on activities to abstract symbols, helped the students build a deeper understanding of geometry.

Table 1: Population of Grade 7 Sampaguita

Section	Number of students (N)	Number of Female	Number of Male
Sampaguita	50	33	17

A. Instrumentation

1. *Teacher-made Test*. The purpose of the 35-item multiple-choice test was to gauge the pupil's grasp of geometry. With seven distinct areas covered, this test provided the researcher with a thorough understanding of the student's knowledge of geometry. This test measured the student's progress by administering it before and after the instructional period. The posttest demonstrated how well the teaching strategies—particularly the Concrete-Pictorial-Abstract (CPA) approach—have improved the students' comprehension of geometric concepts. At the same time, the pretest helped the researcher evaluate where each student sat at the beginning. After thoroughly evaluating its validity and reliability, the test yielded an acceptable reliability index of Cronbach α=0.845. Three experts in mathematics education also looked at its face validity and content to confirm the validity of the questionnaire.
2. *Problem-Solving*. Students were asked to calculate the angles that created parallel lines cut by a transversal or to measure the sides and angles of polygons through these questions. George Polya's approach to problem-solving, which leads students through comprehending the issue, formulating a solution, carrying it out, and finally evaluating their work, served as the model for the scoring methodology they had used. This motivated children to think critically and approach challenges methodically in addition to testing their abilities. Three secondary education specialists examined and validated the test's contents and overall presentation in order to determine its face and content validity.
3. *Interview Guide.* The interview guide was developed to explore students' experiences and perceptions of the CPA approach in Geometry. A purposive sample of 10 students, balanced between high and low performers, participated in a semi-structured group interview, where questions remained adaptable to encourage detailed responses.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

4. *Feedback Survey Questionnaire***.** This instrument has been evaluated its validity and reliability which yielded to its acceptable reliability index of Cronbach **α**=.940. A Likert scale survey was designed to capture students' perceptions of the CPA approach, assessing aspects such as enjoyment of lessons, perceived usefulness, and confidence in Geometry. Feedback from this survey provides insights into student's attitudes and potential impacts on their learning experiences.

RESULTS AND DISCUSSION

A. Students' Performance in the Achievement Test

Table 2: Frequency distribution of the achievement pretest scores of students in geometry

Pretest of the Respondents			Mean Rating with Transmuted Grade	Qualitative Description
Score	**Frequency**	**Percentage**		
29-35	0	0.00%	9.213 /63.161	Developing/ FAILED
22-28	0	0.00%		
15-21	1	2.00%		
8-14	33	66.00%		
1-7	16	32.00%		
TOTAL	*50*	*100.00%*		

Scaling of the level of Proficiency: 1 - 7 =Beginning, 8 - 14 =Developing, 15 -21 =Approaching Proficiency, 22 - 28 =Proficient, 29 – 35= Advanced. Transmuted Grade: below 75.00% = FAILED. Above or equal 75.00% = PASSED

Table 2 shows the respondents' level of understanding of the material. Most of the respondents, about 33 or 66%, are in the 'Developing' stage, meaning they have a basic grasp but still have a lot of room for improvement.1 or 2% are close to being proficient, showing that a few are nearly at a competent level, but no one has fully reached it. While 16 or 32% of the respondents scored in the 'Beginning' range, it's worth noting that they, too, have not met the 75% passing threshold according to the grading criteria.

Overall, these results indicated that, despite some individuals performing well, there's a significant need for better support and instruction to help everyone improve and reach at least a proficient level.

According to Fazio (2020), active learning approaches are effective in assisting students to develop a more robust conceptual understanding, which aligns with the need for better support and instructions. Active learning helps students get to grips with concepts by getting them involved in their education.

Instead of just sitting through lectures, they dive into discussions, tackle real-world problems, and try out hands-on activities. This way, learning becomes more interactive and engaging, making it easier for students to understand and remember what they're studying.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

Table 2: Frequency distribution of the achievement posttest scores of students in geometry

Posttest of the Respondents			Mean Rating with Transmuted Grade	Qualitative Description
Score	Frequency	Percentage		
29-35	21	42.00%	25.404/86.291	Proficient/ PASSED
22-28	13	26.00%		
15-21	14	28.00%		
8-14	2	4.00%		
1-7	0	0.00%		
TOTAL	50	100.00%		

Scaling of level of Proficiency: 1 - 7 =Beginning, 8 - 14 =Developing, 15 -21 =Approaching Proficiency, 22 - 28 =Proficient, 29 – 35= Advanced. Transmuted Grade: below 75.00% = FAILED. Above or equal 75.00% = PASSED

Table 2 reveals that 42% of respondents, or a solid 21, received a score in the "Advanced" range, indicating that they have a very high level of mastery of the subject. Another thirteen, or twenty-six percent, falls into the 'Proficient' level, indicating a firm understanding of the ideas. Also, 14 or 28% are 'approaching competency,' meaning they still have some learning to do but are almost at full competency. Since nobody is at the "Beginning" level and just two, or 4%, are at the "Developing" level, everyone has progressed past the most fundamental comprehension with a passing grade of 86.291 and an average score of 25.404. It is evident that the majority of respondents passed, which is evident by a sizable margin. Compared to where they began, this represents a substantial advance, demonstrating the effectiveness of the efforts to deepen their comprehension. Alshahrani & Alshahrani (2023) investigated the potential effects on math teachers' teaching abilities of a training program focused on conceptual understanding concepts. According to their research, the program significantly impacted teachers' knowledge and students' performance. This demonstrates how employing focused teaching techniques can significantly improve students' understanding of the material.

A. Students' Performance in Problem-Solving

Table 3: Frequency distribution of the pretest in problem-solving in geometry

Pretest of the Respondents			Mean Rating with Transmuted Grade	Qualitative Description
Score	Frequency	Percentage		
25-30	4	8.00%	17.240/78.733	Developing/ PASSED
19-24	14	28.00%		
11-18	23	46.00%		
7-12	8	16.00%		
1-6	1	2.00%		
TOTAL	50	100.00%		

Scaling of level of Proficiency: 1 - 6 =Beginning, 7 - 12 =Developing, 11 -18 =Approaching Proficiency, 19 - 24 =Proficient, 25 – 30= Advanced. Transmuted Grade: below 75.00% = FAILED. Above or equal 75.00% = PASSED

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

Table 3 shows a range of abilities among respondents. Most students, 23 or 46%, are at an "Approaching Proficiency" level, implying they have a good understanding but still need to enhance their skills. Also, 14 or 28% of respondents are at a 'Proficient' level, showing that they have met the expected standards. Additionally, 4 or 8% reached the 'Advanced' level, indicating they have an excellent grasp of the concepts, 8% or 16% are at the developing stage, and 2% of them scored in the 'Beginning' range, which clearly shows that they are struggling with the basics. Overall, the mean score of 17.240 with a transmuted grade of 78.733 suggests that most respondents have passed the test, as their average score is above the 75% passing mark. This result may be due to the fact the respondents have prior knowledge of the subject matter, and that they are in a homogeneous class in which students belong to the speed class. . The study of McGowan and McGowan (2016) supports this result. They pointed out that using various methods, like practical tasks and open-ended questions, gives a better picture of students' problem-solving skills. Using both practical tasks and open-ended questions clearly shows how students solve problems. Practical tasks show how they apply their knowledge in real situations, while open-ended questions reveal their critical thinking and creativity. Together, these methods help teachers see both the skills students use in action and how they understand and approach problems, providing a well-rounded view of their problem-solving abilities.

Table 4*: Frequency Distribution of the Posttest in Problem-Solving in Geometry*

Posttest of the Respondents			Mean Rating with Transmuted Grade	Qualitative Description
Score	Frequency	Percentage		
25-30	40	80.00%	26.26/93.767	Advanced / PASSED
19-24	10	20.00%		
11-18	0	0.00%		
7-12	0	0.00%		
1-6	0	0.00%		
TOTAL	50	100.00%		

Scaling of the level of Proficiency: 1 - 6 =Beginning, 7 - 12 =Developing, 11 -18 =Approaching Proficiency, 19 - 24 =Proficient, 25 – 30= Advanced. Transmuted Grade: below 75.00% = FAILED. Above or equal 75.00% = PASSED

Table 4 shows that 40 or 80% of the respondents scored in the 'Advanced' range, showing that most of the respondents have mastered problem-solving and performed well. Another 10 or 20% is in the 'Proficient' range, meaning they have a solid understanding of the material. No one scored in the lower levels, which means everyone has made significant progress and moved beyond the basics. With an average score of 26.26 and a passing grade of 93.767, it's clear that all respondents passed the test with a comfortable margin. This marks a huge improvement from where they started and highlights the success of the efforts to enhance their problem-solving skills. This result is inconsistent with the study of Putri et al. al (2020). He further asserted that students who learned with the CPA approach had better achievement and improvement in Mathematical reasoning, regardless of their prior mathematical ability level. CPA helped all students grasp mathematical ideas more effectively and develop their problem-solving abilities.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

A. Feedback on the Perceptions of the Respondents on the CPA Approach

Table 5: Mean and Standard Deviation on the Perceptions of CPA Approach

Statements	Mean	SD	Interpretation
1. I feel comfortable using the CPA approach.	4.18	0.80	Agree
2. My understanding of the basic concepts of lines, points and planes has increased.	4.12	0.80	Agree
3. The ability to recognize the lines, points, and planes has increased.	4.30	0.76	Strongly Agree
4. I have developed confidence in my ability using the CPA approach	4.00	0.86	Agree
5. The CPA approach improved my ability to work with my peers.	4.06	0.82	Agree
6. The CPA approach increased my knowledge and awareness in Geometry.	4.16	0.89	Agree
7. The CPA approach helped me develop my critical thinking skills in solving word problems.	4.24	0.74	Strongly Agree
8. The CPA approach increased my interest in Geometry.	4.06	0.82	Agree
9. The CPA approach gave me the confidence to do more activities in math.	4.04	0.81	Agree
10. Using the CPA approach, I can clearly understand the importance of Geometry.	4.14	0.78	Agree
Overall Mean	**4.13**	**0.81**	**Agree**

Scaling: 1.00 – 1.79 = Strongly Disagree, 1.80-2.59 = Disagree, 2.60 -3.39 = Neutral, 3.40 – 4.19= Agree, 4.20 -5.00 = Strongly Agree

Table 5 shows that the CPA (Concrete Pictorial Abstract) approach gains a positive perception from the participants, who found it to be effective (*M=4.13, SD=0.81*). Specifically, the use of CPA helped the students develop their critical thinking skills (*M=4.24, SD=0.74*) and recognize basic geometric concepts such as lines, points, and planes (*M=4.30, SD=0.76*). Students also "agree" that they are comfortable (*M=4.18, SD=0.80*) and give them confidence to do more activities (*M=4.04, SD=0.81*) in using the CPA approach.

It further increased their understanding (*M=4.12, SD=0.80*), knowledge and awareness (*M=4.16, SD=0.89*), and interest (*M=4.06, SD=0.82*) in Geometry. Moreover, the use of CPA has helped the students improve their ability to work with their peers (*M=4.06, SD=0.82*), and the students can clearly understand how important geometry is (*M=4.14, SD=0.78*).

Flores, et. al. (2022) supported this study and found out that the CPA method helps students grasp math concepts better. The high scores on understanding basics, recognizing shapes and lines, and improving critical thinking show that this approach makes a big difference in how well students understand math.

In examining responses to the questions, *"How do you find CPA? Is it helpful or not?"*, we uncovered a range of themes that reflect people's experiences. Many described CPA as helpful and noted that it offers a clear understanding of concepts. Respondents highlighted how engaging and interactive the material is in making it relatable and effective. They mentioned that the content is memorable and accessible, often finding it fun and practical for real-life applications.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

Below are some actual responses from the students.

Student M1: ***"Concrete Pictorial Abstract improves my ability to learn and retain difficult concepts."***

Student M7: ***"CPA technique allows us to use both our hands and our brains; it is incredibly engaging and dynamic."***

Student F5: ***"It keeps me interested, helps me understand the lesson well, and keeps me from getting bored."***

Student F9**:** ***"The CPA presents things or images in a way that makes difficult concepts easier."***

Student M32**:** ***"Everyone can relate to the CPA's tangible experiences, which make every topic engaging, productive, and fun."***

The second question is: *"What are the possible benefits of using the Concrete-Pictorial-Abstract approach in your learning?*" Some students mentioned benefits such as understanding, memory retention, engagement, hands-on learning, visualization, active participation, conceptual clarity, exploration, interactivity, communication skills, confidence building, multi-sensory learning, real-life connections, accessibility, and enjoyment.

The following are some of the actual responses:

Student M23**:** **"*Being able to do practical exercises and create visuals makes my learning more enjoyable."***

Student F28: **"*I became more comfortable sharing my thoughts with others."***

Student M37: **"*I actively demonstrate what I have learned through actions by using my both hands and mind when creating concrete things."***

Student M33: **"*It's easier for me to remember what we studied when I use pictures and drawings."***

Student F22**:** **"*My communication skills improved, and I became more interactive with others."***

Upon highlighting the positive outcomes, it is important to acknowledge that the Concrete Pictorial Abstract (CPA) approach can also present some challenges. This brings us to the question, *"What challenges have you encountered in your learning using CPA?"* Here are some of the students' responses:

Student M49: **"*Classroom resources are limited and costly."***

Student M29: **"*It can be challenging to understand how the CPA components all fit together at times when the connections between them are unclear.*"**

Student M35: **"*It's difficult to find the right objects or materials to represent a topic, and sometimes I find it harder to understand using concrete items*."**

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

Student F11: *"It can be costly and time-consuming to work with concrete materials."*

Overall, the Concrete-Pictorial-Abstract (CPA) approach provides many positive benefits, helping students grasp concepts and stay engaged. However, it's important to recognize that it also has its challenges. By being aware of both the strengths and the difficulties that students encounter, educators can adjust their methods to better support everyone. Finding this balance is essential for creating an environment where all students can thrive and feel confident in their learning experiences.

D. A Comparison of the Pretest and Posttest Scores of the Students in Conceptual Understanding

Table 6: Wilcoxon-Signed Ranks Test Scores for Conceptual Understanding

Variable	Wilcoxon Test	P-value
Pretest and Posttest	-6.159	0.000*

* Significant at 0.05

Table 6 compares the pretest and posttest in terms of conceptual understanding of the respondents using the nonparametric test called the Wilcoxon-Signed Ranks Test to describe the learners' performance. The result of this test further revealed a statistically significant difference in the learners' conceptual understanding before and after the intervention *(Z= -6.159 p = 0.000 <0.05)*. This result testified that based on the difference in mean ranks, the conceptual understanding of the learners in the pretest differed from their performance after the posttest. Therefore, implementing the CPA Approach positively affected the conceptual knowledge of the learners in this group. According to Freeman et al. (2014), active learning—where students are actively engaged in learning—dramatically improves their performance and understanding of subjects like math. This shows that using active learning strategies instead of just lecturing can lead to much better results, as evidenced by the higher scores students achieved on their post-tests.

Table 7: Wilcoxon-Signed Ranks Test Scores for Problem Solving

Variable	Wilcoxon Test	P-value
Pretest and Posttest	-6.014	0.000*

* Significant at 0.05

Table 7 compares the pretest and posttest in terms of problem-solving of the respondents using the nonparametric test called the Wilcoxon-Signed Ranks Test to describe the learners' performance. The result of this test further revealed a statistically significant difference in the problem-solving of the learners before and after the intervention *(Z= -6.014 p = 0.000 <0.05)*. This result testified that based on the difference in mean ranks, the problem-solving of the learners in the pretest differed from their performance after the posttest. Therefore, the implementation of the CPA Approach had a positive effect on the problem-solving of the learners in this group. Clements et. al (2023) found that this method helps students get better at solving problems by giving them a strong understanding of the basics. The improved scores

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

on post-tests show that this approach works well in boosting students' problem-solving skills.

As part of their analysis, students were given the problem: A regular polygon has an interior angle of 120 degrees. How many sides does it have? In Figure 1, student SF12 worked on this during the pretest and received 1 out of 5 points. Although she used the correct formula, she struggled with substituting the right values for the variables, which resulted in an incorrect answer. In Figure 2, she scored 4 means she used the correct formulas with the correct substitution of the numbers leading to a correct final answer, but she failed to solve the measure of the third angle.

To find out how many sides a regular polygon has when its interior angle measures 120 degrees, use the formula for the interior angle of a regular polygon. This formula relates the angle to the number of sides, which is n. By setting the interior angle equal to 120 degrees, the equation $\frac{(n-2)x\ 180}{n} = 120$. Multiply both sides by n, we have $(n-2)X180 = 120n$. Expanding this equation leads to $180n - 360n = 120n$. By combining like terms, $180n - 120n = 360$, which simplifies to $60n = 360$. Finally, when solved for n, the value of n = 6. The regular polygon with an interior angle of 120° is a hexagon, meaning it has 6 sides.

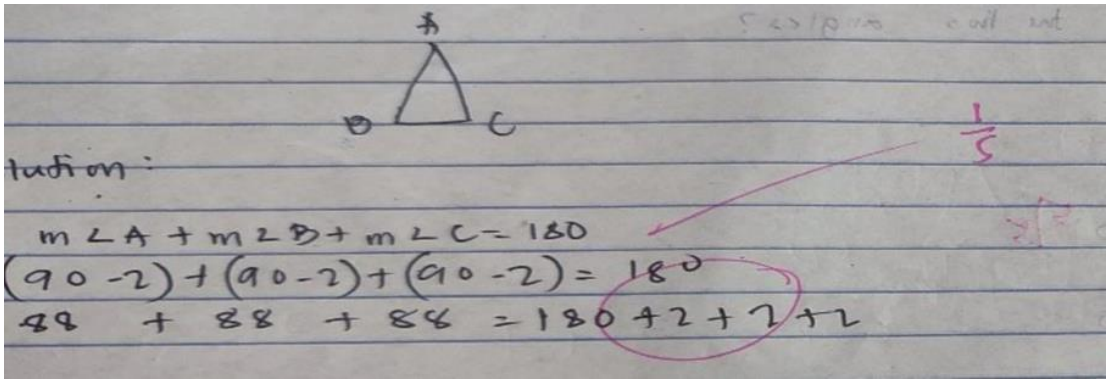

Figure 1: Solution for measuring the interior angles of a triangle constructed by student SF12 (pretest)

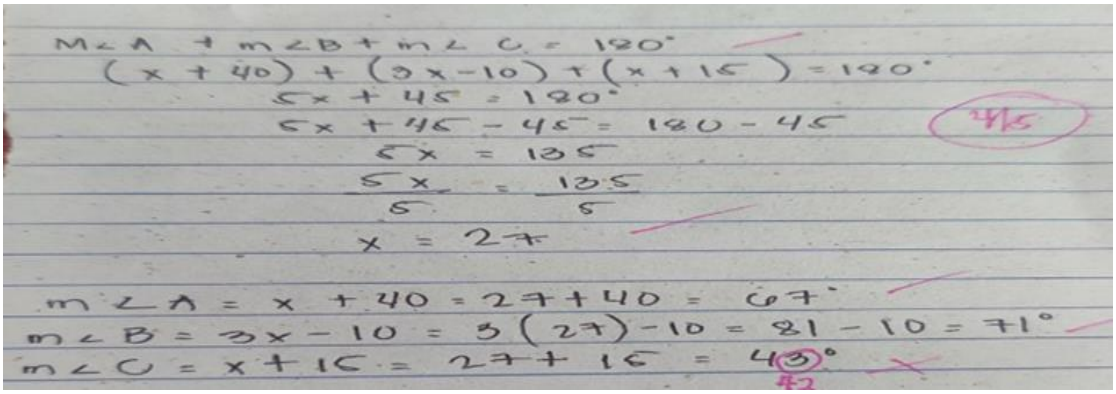

Figure 2: Solution for measuring the interior angles of a triangle constructed by student SF12 (posttest)

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

To determine how many sides a regular polygon has when its interior angle measures 120°, use the formula for the interior angle of a regular polygon: Interior angle denoted by $= \frac{(n-2)x180}{n}$, where *n* represents the number of sides. Setting the interior angle equal to 120°,

$120 = \frac{(n-2)x\ 180}{n}$, multiply both sides by *n*

$120n = (n-2)x\ 180$

$120n = 180n - 360$

$360 = 180n - 120n, which\ simplifies\ to\ 360 = 60n.$

Solving for *n* results in *n* = 6. Thus, a regular polygon with an interior angle of 120° has 6 sides.

In Figure 3, student SF11 scored 3 out of 5 on her pretest. She did a great job identifying the problem and using the right formula, but a mistake in her calculations led to an incorrect answer. Figure 4, she scored a perfect 5 out of 5, successfully using the correct formula and values, and arriving at the right solution.

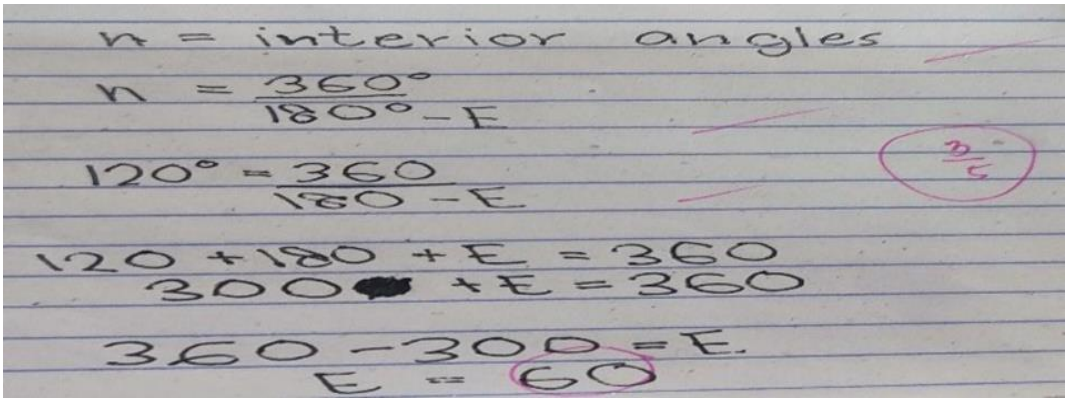

Figure 3: SF11's solution for measuring each interior angle of a polygon (pretest)

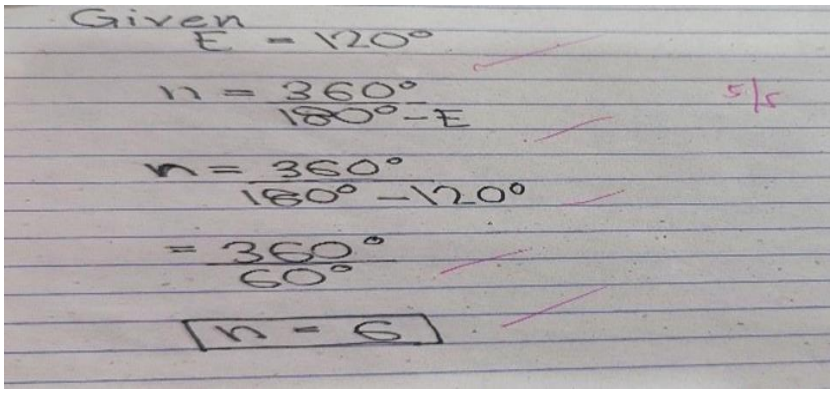

Figure 4: SF11's solution for measuring each interior angle of a polygon (posttest)

In Figure 3, student SF11 scored 3 out of 5 on her pretest. She did a great job identifying the problem and using the right formula, but a mistake in her calculations led to an incorrect

ISSN 1533-9211

DOI: 10.5281/zenodo.14196636

answer. Figure 4, she scored a perfect 5 out of 5, successfully using the correct formula and values and arriving at the right solution.

When a transversal intersects two parallel lines, ⌊1, and ⌊2, the same-side interior angles that are formed are supplementary, which means they add up to 180°. We have one angle given as (2x – 7) ° and the other angle given as (3x – 13) °. To find the measures of these two angles, we can set up the equation (2x – 7) + (3x – 13) = 180. When we combine the terms, we end up with 5x - 20 = 180. Adding 20 to both sides gives us 5x = 200, and dividing by five results in x = 40. Now, substituting this value back into the angle expressions, we calculate the first angle as 2(40) – 7 = 73° and the second angle as 3(40) – 13 = 107°. Therefore, the measure of the two angles is 73° and 107°.

In Figure 5, student SM7 struggled on the pretest, scoring just 1 out of 5 because he didn't use the correct formula, which led to an incorrect final answer. However, in Figure 6, there's a clear improvement in his posttest score of 3 out of 5. This shows that he managed to grasp the correct formula, substitute the values properly, and work through the solution, ultimately leading to the right answer.

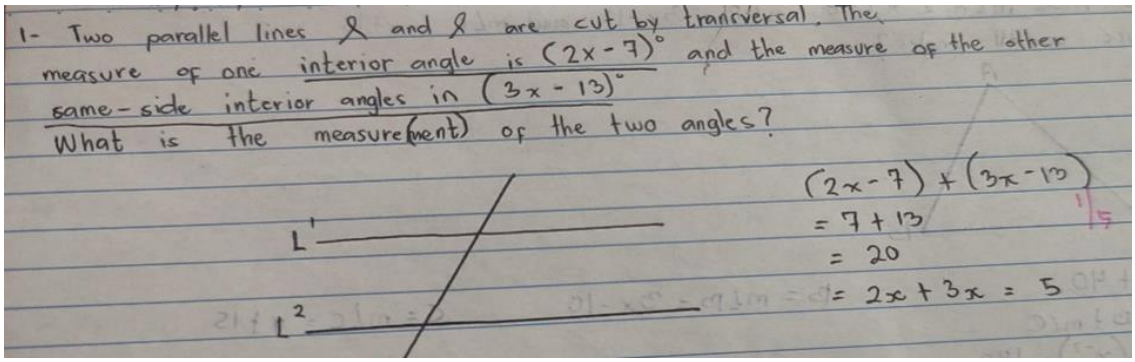

Figure 5: SM7's solution for measuring two angles formed by parallel lines cut by a transversal (pretest)

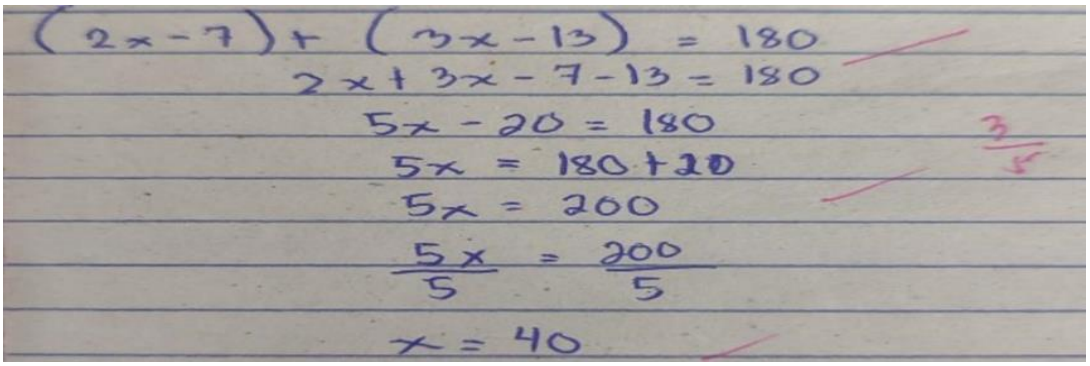

Figure 6: SM7s solution for measuring two angles formed by parallel lines cut by a transversal (posttest)

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

CONCLUSIONS AND RECOMMENDATIONS

This study concluded that the Concrete-Pictorial-Abstract (CPA) method greatly enhanced students' understanding and problem-solving skills, particularly in geometry. Following the implementation of the CPA strategy, the majority of the students showed outstanding improvements in their performance, advancing from primary to higher levels of proficiency. Moreover, the students perceived their feelings as more confident, engaged, and excited about the technique introduced in class, showing staggering evidence from the students' performance. Therefore, the CPA method technique is highly effective in integrating discussions, especially in the mathematics class of grade seven at the junior high school level.

From the drawn conclusions of the study, it is highly recommended that the Concrete-Picture-Abstract approach be integrated more often in mathematics classes. Educators must attend adequate training for its innovative application incorporating technology, opportunities for peer collaboration, and constant assessments, which can all contribute to improved learning outcomes and enhanced competencies among students. Future researchers would also benefit from exploring the long-term impacts of CPA and its potential application in other disciplines of mathematics to enrich student success further.

Acknowledgment

The researcher humbly takes this opportunity to sincerely thank everyone who made this study possible. First and foremost, to her adviser, Dr. Coronado**,** who persistently shared his brilliant ideas in completing this paper to the last journey. To the panel of judges, Dr. Cadeliña, Prof. Lim, and Prof. Jarlata, who also contributed enormous ideas and suggestions to furnish this paper. Also, the researcher is sincerely grateful to the school director of MSU - University Training Center and the school principal for their support and guidance. Most specially, a huge thank you to the grade 7 students who participated in this study—you truly made it meaningful with your insights. The researcher also wants to extend her heartfelt appreciation to her family, friends, and co-teachers. Your encouragement and willingness to help her along the way have meant the world to her. Thank you all for being such a supportive and open-hearted community. And most importantly, the researcher is deeply grateful to the Almighty for the guidance and blessings that made this study possible.

References

1) Aguhayon, H.G., Tingson, & Pentang, J.T. (2023). Addressing Students Learning Gaps in Mathematics through Differentiated Instruction. International Journal of Educational Management and Development Studies, 4 (1), 69-87. https://doi.org/10.53378/352967

2) Agustin, Gemma. (2023). Concrete Pictorial Abstract (CPA) Approach in Mathematics Problem Solving. IARJSET. 10. 10.17148/IARJSET.2023.107109.

3) Al-Shahrani A, (2023). "The Effect of Conceptual Understanding Principles-Based Training program on enhancement of Pedagogical Knowledge."

4) Athienitis, A. (2022, April 1). *The Concrete-Pictorial-Abstract approach in mathematics*. EdShed. https://blog.edshed.com/what-is-the-cpa-approach-explained/

5) Clements, D. H., Lizcano, R., & Sarama, J. (2023). Research and Pedagogies for Early Math. *Education Sciences*, *13*(8), 839. https://doi.org/10.3390/educsci13080839

6) Fazio (2020). Assessing and Improving Conceptual Understanding in Undergraduate Biology: A Systematic Review of Effective Practices."

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.14196636

7) Flores, M. M., & Hinton, V. M. (2022). Use of the Concrete–Representational–Abstract Instructional Sequence to Improve Mathematical Outcomes for Elementary Students With EBD. *Beyond Behavior*. https://doi.org/10.1177/10742956211072421

8) Freeman (2014). Active Learning Increases Students Performance in Science, Engineeringh and Mathematics.

9) Geary, D. C., Berch, D. B., & Mann Koepke, K. (2019). *Cognitive foundations for improving mathematical learning* (First edition.). Academic Press, An imprint of Elsevier

10) Geary, D. C., Hoard, M. K., Nugent, L., Chu, F., Scofield, J. E., & Ferguson Hibbard, D. (2019). Sex differences in mathematics anxiety and attitudes: Concurrent and longitudinal relations to mathematical competence. *Journal of Educational Psychology, 111*(8), 1447–1461. https://doi.org/10.1037/edu0000355

11) Haw, Joseph & King, Ronnel. (2023). Understanding Filipino students' achievement in PISA: The roles of personal characteristics, proximal processes, and social contexts. Social Psychology of Education. 26. 1-38. https://doi.org/10.1007/s11218-023-09773-3 https://www.philstar.com/headlines/2023/12/07/2317044/pisa-philippines-5-6-years-behind

12) McGowan and McGowan (2016) Assessing Problem Solving in Mathematics. Nair, S., Smith, J., & Johnson, L. (2020). The power of visual communication: Using infographics for knowledge mobilization in research. Journal of Visual Communication Studies, 12(1), 35-50.

13) Putri, H.E., Suwangsih, R., Rahayu, P., Nikawanti, G., Enzelina, E., and Wahyudy, M.A. (2020). Influence of Concrete-Pictorial_Abstract (CPA) Approach on the enhancement of Primary School students' Mathematical Reasoning Ability. *Mimbar Sekolah Dasar, Vol 7(1) 2020, 119-132. DOI: 10.17509/mimbar-sd. v7i1.22574*

14) Salami, M., Suhartono, S., Hidayah, R., & Fajari, L. E. W. (2020, October 1). Improving mathematics learning of geometry through the concrete-pictorial-abstract (CPA) approach: collaborative action research. *Journal of Physics: Conference Series*, *1663*(1), 012046. https://doi.org/10.1088/1742-6596/1663/1/012046