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ENHANCING STUDENTS' UNDERSTANDING OF MATHEMATICAL CONCEPTS THROUGH THE CONCRETE-PICTORIAL-ABSTRACT (CPA) APPROACH IN LEARNING FRACTIONS

Erna Sari Agusta

MTsN 28 Jakarta, Jl. Rawakuning No. 32 Pulogebang Cakung Jakarta Timur

*Email: ernasari.agusta@gmail.com

Abstract

Conceptual understanding can be demonstrated by students in restating concepts, classifying objects, presenting concepts, selecting and using procedures, and applying concepts in problem-solving. In reality, students of MTsN 28 Jakarta still struggle to solve everyday problems due to their limited conceptual understanding ability. The purpose of this study was to describe the implementation of the CPA (Concrete-Pictorial-Abstract) approach in mathematics learning, as well as to examine the improvement of students' mathematical concept understanding abilities in fraction material with the CPA approach in class VII-F MTs Negeri 28 Jakarta. This study employs a Classroom Action Research (CAR) design conducted in two cycles. Each cycle consists of stages of planning, implementation, observation, and reflection. The research subjects observed in the study were six students from the upper, middle, and lower groups. Data analysis refers to the evaluation of indicators of conceptual understanding abilities, as observed in the research subject's test answers, which are presented through three stages: data reduction, data presentation, and conclusion. The study's results showed that the average test scores increased from Cycle I to Cycle II. Student learning completeness also increased from the Cycle I and Cycle II tests. Thus, the CPA approach can improve students' ability to understand mathematical concepts.

Keywords: Concept Understanding Ability, CPA Approach, Fraction

Abstrak

Pemahaman konseptual dapat ditunjukkan siswa dalam menyatakan ulang konsep, mengklasifikasikan objek-objek, mempresentasikan konsep, memilih dan menggunakan prosedur, dan mengaplikasikan konsep dalam pemecahan masalah. Pada kenyataannya, siswa MTsN 28 Jakarta masih kesulitan dalam memecahkan masalah sehari-hari karena kemampuan pemahaman konseptual mereka yang terbatas. Tujuan dari penelitian ini adalah untuk mendeskripsikan implementasi pendekatan CPA (Concrete-Pictorial-Abstract) dalam pembelajaran matematika, serta mengkaji peningkatan kemampuan pemahaman konsep matematis siswa pada materi pecahan dengan pendekatan CPA di kelas VII-F MTs Negeri 28 Jakarta. Penelitian ini menggunakan desain Penelitian Tindakan Kelas (PTK) yang dilakukan dalam dua siklus. Setiap siklus terdiri dari tahap perencanaan, pelaksanaan, observasi, dan refleksi. Subjek penelitian yang diamati dalam penelitian ini adalah enam orang siswa dari kelompok atas, menengah, dan bawah. Analisis data mengacu pada evaluasi indikator kemampuan pemahaman konsep, sebagaimana diamati pada jawaban tes subjek penelitian, yang disajikan melalui tiga tahap yaitu reduksi data, penyajian data, dan kesimpulan. Hasil penelitian menunjukkan bahwa nilai rata-rata tes meningkat dari Siklus I ke Siklus II. Ketuntasan belajar siswa juga mengalami peningkatan dari tes Siklus I dan Siklus II. Dengan demikian, pendekatan CPA dapat meningkatkan kemampuan siswa dalam memahami konsep matematika.

Kata kunci: Kemampuan Pemahaman Konsep, Pendekatan CPA, Pecahan

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INTRODUCTION

Conceptual understanding is the first skill that students must master. With a solid understanding of concepts, students can develop their critical thinking and reasoning skills, enabling them to solve a range of problems. The results of the (Rittle-Johnson et al., 2015) study concluded that one of the obstacles to learning mathematics is the lack of skills to face and adapt to new situations quickly and effectively, as well as to understand and utilize abstract concepts effectively, and recognize and learn relationships quickly. On the other hand, the results of the (Ardila & Hartanto, 2017) study stated that Fractions are one of the essential concepts that students should master, from their introduction to their application.

Based on the results of the initial ability test, it was discovered that the understanding of the concept of fractions was still lacking. Fractions are often considered difficult by students because they require a deep understanding. Based on the results of observations, it is known that the difficulty in understanding the concept of fractions is due to the absence of visualization or approaches through concrete objects. Without aids such as pictures, diagrams, or manipulatives, students struggle to understand the relationship between parts and the whole in fractions. The use of minimal concrete media can cause students to be confused in understanding the basic concept of fractions (Novianto et al., 2024).

In addition, the teaching style of teachers with traditional teaching methods that only focus on memorizing formulas without providing real experience makes it difficult for students to apply the concept of fractions in the context of everyday life. Based on the results of these observations, teachers need to innovate in mathematics learning. Teachers as educators are required to be able to carry out teaching with interesting learning methods/strategies, or create learning tools that can make it easier for students to understand mathematics, with creative ideas from teachers, fun learning strategies, and complete teaching materials, of course, can make students feel comfortable and interested and students can understand mathematics well.

As a result of the observation, it was found that learning experiences that did not involve students often caused them to be less motivated to learn mathematics because they considered it difficult or irrelevant to their lives. The purpose of this study was to describe the implementation of the CPA (Concrete-Pictorial-Abstract) approach in mathematics learning, as well as to investigate the improvement of students' mathematical concept understanding abilities in fraction material using the CPA approach.

The CPA (Concrete-Pictorial-Abstract) approach is an instructional approach to the development of primary mathematical concepts in Singapore. The Concrete Pictorial Abstract approach is based on Bruner's theory of enactive, iconic, and symbolic representation of cognitive growth (Chang et al., 2017). Chang as quoted by (Hoong et al., 2015), revealed that Bruner's idea is the heart of the Concrete Pictorial Abstract approach. According to the CPA Approach, it also consists of three learning steps: Concrete (manipulation of real objects), Pictorial (use of images), and Abstract (use of something that is already abstract). The pictorial stage is a transition that represents the results of the concrete stage, typically in the form of images. Furthermore, the third stage is the abstract stage, where a mathematical concept is presented symbolically using numbers, variables, and other mathematical symbols. The stages in the CPA approach are closely interrelated, forming a cohesive unit that supports the success of learning activities. These stages can build upon previous knowledge, helping students understand concepts in mathematics.

The CPA approach aims to strengthen students' mathematical understanding because at the beginning of the learning stage, students begin to develop problems concretely so that they better understand the process of solving problems at the abstract stage. The use of concrete objects or situations can help improve students' understanding better so that the learning process becomes meaningful. Through the stages above, students can remember the concepts and relationships taught by the teacher (Flores, 2010). According to Flores, the steps to implement the CPA approach are as follows: 1). Provide students with concrete objects or tangible items related to the material being discussed, which strengthens conceptual understanding, 2). Provide direction and instructions to students so that they can participate independently in using concrete objects or

things, 3). Change the use of selected concrete objects into pictures or paintings, 4). Apply strategies that help students recall the learning steps they have previously taken. This functions as a transition process from using pictures or paintings to using symbols, and 5). Guide students to focus on using numbers or symbols only in solving mathematical problems. This activity is helpful for their fluency in solving problems.

In line with this opinion, Sousa argues that the CPA approach is learning by physically manipulating concrete objects, learning by drawing substantial manipulation representations, and solving problems using abstract notation. Several experts state that the application of the CPA approach can improve mathematics learning. The results of (Aan Yuliyanto, Turmudi, Mubiar Agustin et al., 2020) stated that the application of the CPA approach can improve mathematical connection skills and learning outcomes in grade V of Elementary School. These results are also reinforced by (Purwadi et al., 2019), which states that the CPA approach can enhance the understanding of mathematical concepts and improve mathematics learning in the classroom. Furthermore, it is said that the CPA approach, with manipulating concrete objects, is beneficial in helping students who have difficulty understanding mathematical concepts.

Conceptual understanding ability is the ability to understand concepts, operations, relations in mathematics (Findell, B., Swafford, J., & Kilpatrick, 2001). With conceptual understanding, students are expected to demonstrate an understanding of the mathematical concepts they have learned, explain the relationships between concepts, and apply concepts or algorithms flexibly, accurately, efficiently, and precisely in problem-solving. Indicators of mathematical conceptual understanding ability in this study are limited to: a) Restating a concept that has been learned, b) Classifying objects according to specific properties according to their concepts, c) Presenting concepts in various forms of mathematical representation, d) Selecting and using certain procedures or operations, e) Applying concepts or algorithms in problem-solving (Zulkarnain, I., & Budiman, 2019).

Students learn through something concrete. Based on several opinions above, it can be said that the ability to understand mathematical concepts is the ability of students to understand and comprehend an abstract idea or basic principle of a mathematical object, where not only remembering and knowing what has been learned but also being able to express it again in another form that is easy to understand and apply it in solving a mathematical problem. According to (Piaget, 1976) to understand abstract concepts, children need concrete (real) objects as intermediaries. Furthermore, the newly understood abstract concept will settle, stick, and last a long time if he learns through doing and understanding the meaning, not just by remembering facts. One of the concrete objects that can serve as an intermediary for students to understand concepts is called media (Widodo & Wahyudin, 2018).

This view is in line with the opinion of (Puspitarini & Hanif, 2019), who stated that media in learning can not only overcome the various limitations of experience possessed by two students living in different environments with different experiences but also make students more interested in the learning process. In addition, media can also in still basic concepts that are correct, concrete, and realistic. Thus, it can be said that with media, new desires, motivations, stimuli, and interests in learning can be aroused because media can provide an integral experience from something concrete to something abstract.

METHOD

The approach used in this research is a qualitative approach with the type of Classroom Action Research (CAR) which is carried out in three cycles. The procedure that takes place in each cycle consists of four stages, namely: planning, implementation, observation, and reflection (Altrichter et al., 2002). The research subjects observed in the study were six students. The criteria for selecting the research subjects were based on the results of the pre-research test. The results of this test become the basis for classifying upper, middle, and lower groups students which are ranked from the highest to the lowest scores.

The data collection techniques employed in the study included administering pre-research tests in the form of essays, using observation sheets in each cycle, taking field notes at each meeting during the learning process, administering final tests at the end of each cycle, conducting interviews with research subjects, and documenting the learning process. The thing that needs to be analysed is the improvement of students' conceptual understanding abilities by applying CPA (Concrete-Pictorial-Abstract) during the learning process. After the data is analysed and evaluated, a reflection is held to consider improvements for the next meeting.

The validity of the data is ensured through the triangulation of sources and investigators. The analysis is guided by the Miles and Huberman analysis technique, which involves reducing, presenting, and concluding the data (Miles, M. B., Huberman, A. M., & Saldaña, 2014). The data analysis framework for conceptual understanding abilities utilizes five indicators of conceptual understanding: restating concepts, classifying objects, presenting concepts, using procedures, and applying concepts. Data analysis of conceptual understanding abilities was only carried out on the results of the research subject's test answers conducted at the end of the cycle.

A complete overview of the CPA approach obtained from observation is just supporting data used to search one of the causes of non-fulfilment students' ability to understand concepts. The criteria that become indicators of success in this research are increasing students' ability to understand concepts, especially those related to six research subjects in every cycle. The six research subjects represented students from upper, middle, and lower socioeconomic classes, with two students from each class, who were selected based on the results of observations of their learning activities in class. Table 1 is an assessment guide for the ability to understand concepts:

Table 1. Rubric for Assessment of Mathematical Concept Understanding Ability

No	Indicator	Score
1.	Restating a concept that has been learned	
	a. Restating the concept of fractions very accurately, including the numerator, denominator, and their meaning.	4
	b. Restating the concept of fractions well, although there are a few minor errors.	3
	c. Restating the concept of fractions partially correctly, but there are fundamental errors.	2
	d. Not understanding the concept of fractions correctly or making many errors.	1
2.	Classifying objects according to certain properties according to the concept	
	a. Explaining the classification criteria in detail and clearly, according to the concept taught.	4
	b. Explaining the classification criteria well, but there are some details that are lacking.	3
	c. Understanding the criteria for objects in general, but the explanation is unclear.	2
	d. Unable to explain the criteria for classifying objects.	1
3.	Presenting concepts in various forms of mathematical representation	
	a. Presenting concepts very clearly and neatly in various forms of representation.	4
	b. Presenting concepts clearly, although there are some minor deficiencies in the visual presentation.	3
	c. Several minor errors that affect the clarity of the presentation of the representation.	2
	d. The representation of the concept is unclear and confusing. There are many errors in the form of presentation.	1
4.	Selecting and using certain procedures or operations	
	a. Selecting the most appropriate and efficient procedure or operation to solve the problem.	4
	b. Selecting the right procedure, but less efficient than other possible options.	3
	c. Selecting a procedure that is less appropriate, but can still be used to solve the problem even though it is less efficient.	2
	d. Selecting the wrong or irrelevant procedure so that it cannot solve the problem.	1

No	Indicator	Score
5.	Applying concepts or algorithms to problem solving	
a.	Applying concepts or algorithms correctly and following all procedural steps correctly.	4
b.	Applying the algorithm well, but there are minor errors in the solution steps, do not affect the final result.	3
c.	Applying the algorithm with several errors that result in minor errors in the final result.	2
d.	Unable to apply the algorithm correctly and produce many errors in the solution process.	1

RESULTS AND DISCUSSION

Students' difficulties in learning mathematics are classified into three types: difficulties in using concepts, difficulties in applying principles, and difficulties in solving verbal problems. Therefore, the right learning approach between teachers and students needs to be considered (Amir & Andong, 2022). Based on the results of the student diagnostic test, it is known that only 25.64% of students scored above the KKM (> 75). This is supported by the results of a questionnaire given to 127 students which showed that 81% of students did not understand the subject matter given by the teacher, 52.4% of students were confused by the teacher's explanation, 28.6% of students often asked for explanations of the material, 26.8% of students could not do mathematical calculations, 45.2% of students were not enthusiastic about learning mathematics, 41% of students did not do exercises and assignments on time, and 19% of students were afraid to learn mathematics.

In cycle I, before implementing the learning, the teacher prepares manipulative media in the form of quadrilateral and circle models that students will use to learn the concept of fractions. In the first meeting, the teacher provided an overview of the context of fractions in everyday life and conveyed the objectives of the fraction learning material. Students formed groups and identified the fraction values $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$ using quadrilateral and circle models. Then, students drew other fraction values based on their understanding in their notebooks. Based on the pictures made, students compared the fraction values.



Figure 1. Learning activities in cycle I meeting 1

In the second meeting, students observed two flat geometric models with different fractional values. The teacher asked students to combine the fractional values of the two flat geometric

models. Then, students drew each flat geometric model and shaded it according to its fractional value. Then, students divided the shaded area on each flat geometric model into several equal parts. Based on the drawings made, students can determine the result of the sum of the shaded areas of the two flat geometric models.



Figure 2. Learning activity cycle I meeting 2

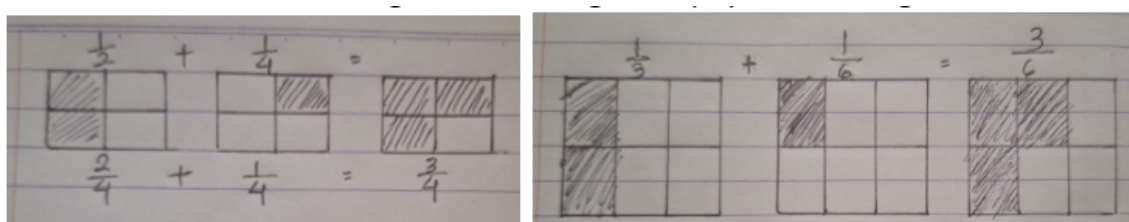


Figure 3. Student work result on addition

In the third meeting, students observe $\frac{1}{3}$ of the plane geometry model. The teacher asks students how to determine $\frac{1}{4}$ of the plane geometry model. Students draw $\frac{1}{3}$ of the model and divide each part into 4 parts. Based on the drawing made, students can determine the result of $\frac{1}{4} \times \frac{1}{3}$, as presented in the picture.

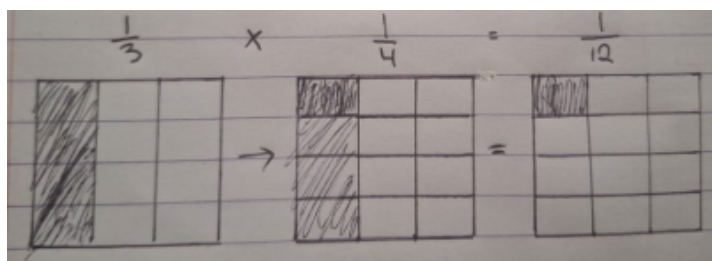


Figure 3. Student work result on multiplication

Based on the results of observations, it is known that some students are still wrong in determining the number of parts in the shaded area. This is caused by the shape of the flat model selected being less symmetrical, resulting in inaccurate measurements when drawing it. Typically, this occurs among students from lower-middle-class backgrounds. To determine the ability to understand concepts, students are given 10 knowledge questions. The results of the assessment in cycle I showed that the percentage of learning completeness had only reached 71.875%. The lowest scores are generally in the indicators of selecting and using certain procedures or operations and applying concepts or algorithms to problem-solving.

Interviews were also conducted regarding students' impressions and learning experiences using the CPA approach. In general, students are happy with the CPA approach, especially middle and low students. They said that CPA's approach is to learn by playing, so they feel more comfortable, no longer afraid of mathematics. The activities carried out make them feel involved in learning, so that they can understand the lesson material well. The results of this interview are supported by the results of other studies which state that mathematical connection ability of

elementary school students who were taught using CPA learning approach is enhanced than the elementary school students who were taught using conventional learning as a whole group of high and low achiever students according to their mathematical prior ability (Putri et al., 2018). However, they still find it challenging to divide building models that are not symmetrical in shape. To overcome this, in Cycle II, the teacher will focus more on the shapes of squares, rectangles, and circles, and place more emphasis on learning through case studies or problem-solving questions.

In Cycle II, learning is emphasized more through case studies that provide context for everyday life problems. In the first meeting, the teacher gave a case study related to food division. Students practiced dividing food based on their understanding of the previous fraction concept. Then, students drew the shape of the fraction in their notebooks. Based on the picture they made, students explained the solution to the case study.

To solve this problem, students used rectangular and circular food. Initially, students would divide their food into four parts, and separate 1 part to be given to the first child. Then, the students tried to divide the 3 remaining parts of the food by dividing each food into two smaller parts, so that there were 6 remaining parts of the food in total. A total of 3 parts of the food were given to the second child, and the other three parts would be eaten by the father and mother equally. Therefore, the students divided the remaining food in half again, resulting in 6 smaller parts of the food.



Figure 4. Learning activity cycle II meeting 1

At the second meeting, the teacher presented a case study comparing two fractional parts from two different flat shape models with the same side lengths. To find out, students draw models of two flat shapes side by side. Based on the picture created, students can conclude that a square shape has a larger part than a circle shape.

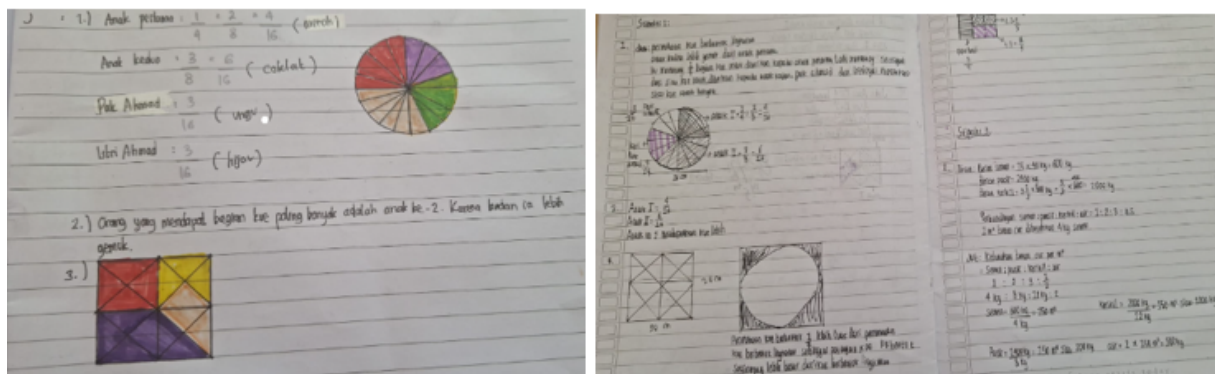


Figure 5. Student work result cycle II meeting 2

At the third meeting, the teacher asked each group to complete numeracy literacy questions related to fractions. Each group presents the results of their discussion, and the other groups

respond. The teacher reinforces to help students understand the concepts. At the end of the lesson, the teacher and students reflect on what they have learned. Based on the results of the reflection, it is evident that students can understand the context of the problem, enabling them to choose and apply procedures and concepts in solving problems.

At the end of cycle II, students worked on 10 daily knowledge assessment questions to determine their ability to understand mathematical concepts. Based on the test results, it is known that the completion percentage has reached 100%. Based on the results of the interviews in Cycle II, it is evident that the CPA approach has a minimal impact on problem-solving for high-category students. This is because they already have good initial knowledge. However, middle and low-category students believe that the use of concrete objects, which have been done before, is very impactful because it makes it easier for them to understand and solve problems. Some of the students' answers are presented in the picture below.

At the concrete stage, teachers bring abstract material into concrete form and practice it with concrete media to provide a concrete understanding of mathematical concepts, making students more enthusiastic about learning, and also aligning with the students' developmental stage. This aligns with (Suryaningsih, 2025) opinion, who stated that the CPA approach utilizes models or teaching aids as a bridge to student understanding, enabling students to comprehend teaching materials and develop their mathematical thinking. Furthermore, the use of concrete media in learning can generate conceptual ideas, thereby reducing the likelihood of misconceptions and providing a foundation for understanding and concrete concepts to supplement verbal comprehension. This approach also offers real experiences that stimulate students' learning motivation, making the learning process deeper and more diverse (Irfan et al., 2019).

At the pictorial stage, the teacher converts the concrete model into a semi-concrete one by incorporating pictures from concrete media, allowing students to draw concrete objects according to their size. In this second stage, students will expand on the understanding obtained in the previous stage and build strong memories of understanding mathematical concepts in semi-concrete situations. Learning using the CPA method helps students interpret the meaning of abstract symbols by relating them to concrete objects, allowing students to build memories of images that can be recalled when they have difficulty interpreting abstract symbols (Agustina, 2024).

At the abstract stage, all learning materials and media are in abstract form, and students will learn to understand mathematical concepts through symbols, number notations, and mathematical symbols. In the picture, the portion of food given to each person is given a different colour. By using the picture, it appears that $\frac{1}{4}$ of the part is equal to $\frac{4}{16}$, half of $\frac{3}{4}$ is $\frac{3}{8}$ or $\frac{6}{16}$, and half of $\frac{3}{8}$ is $\frac{3}{16}$. Building on the understanding gained from the previous stage, students will enter a learning stage that helps them form meaningful relationships between abilities at the concrete, semi-concrete, and abstract levels. This aligns with the opinion (Hinton & Flores, 2019) that student understanding begins at the concrete level, utilizing visual experiences to build understanding. Next, students expand their understanding through pictorial representations of concrete objects, and then students move on to the abstract level of understanding.

To assess students' ability to understand concepts, a formative test is administered. The percentage of achievement of each indicator of understanding concepts is presented in Table 2.

Table 2. Recapitulation of Achievement of Conceptual Understanding Ability

No	Indicator Concept Understanding	Percentage	
		Cycle I	Cycle II
1.	Restating a concept that has been learned	83%	95%
2.	Classifying objects according to certain properties according to their concepts	82%	94%
3.	Presenting concepts in various forms of mathematical representation	79%	90%
4.	Selecting and using certain procedures or operations	68%	84%
5.	Applying concepts or algorithms to problem solving	65%	78%

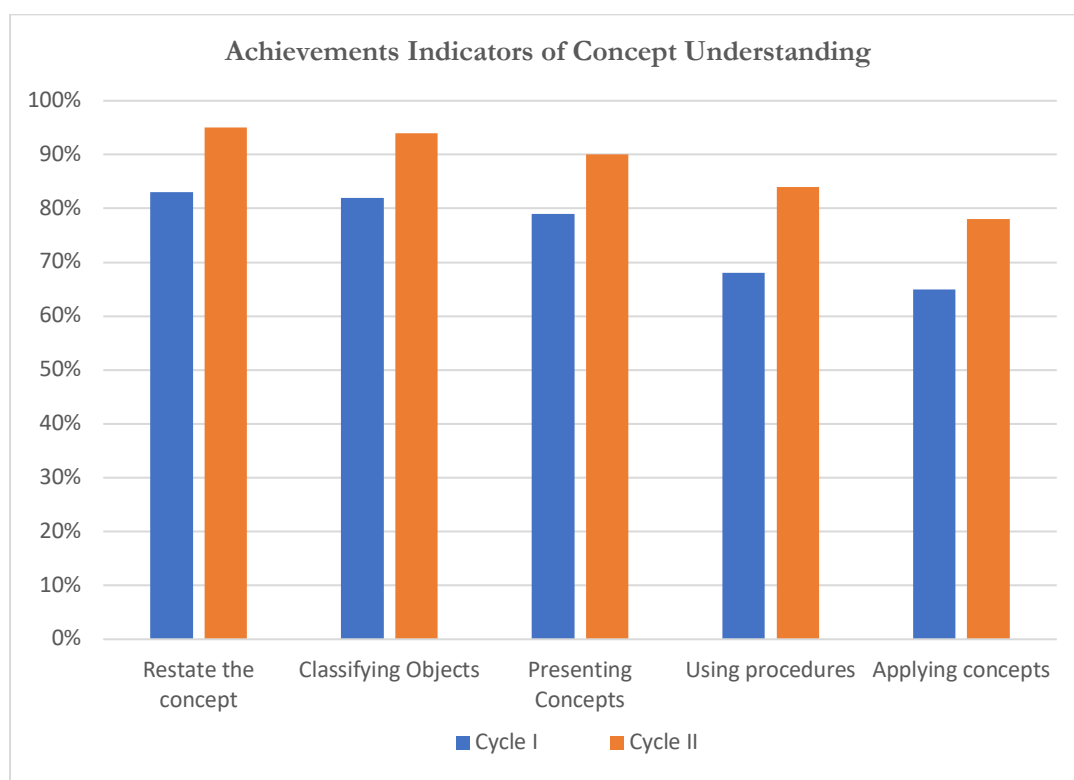


Figure 5. Achievements Indicators of Concept Understanding

The picture above shows that all students can master indicators 1, 2, and 3. However, there are still students who have not mastered indicators 4 and 5. Based on the results of the analysis of the answers in Cycle I, it is known that 32% of students still make mistakes in choosing and using procedures or operations to solve the given problems. Additionally, 35% of students still struggle with applying concepts or algorithms in problem-solving. This aligns with the Newman procedure, which explains that among the factors contributing to student error in solving problems are transformation error and process skill error. Process skills error is a condition where students do not know the correct procedure or steps to solve a problem. According to (Rohmah & Sutiarto, 2018), factors affecting students' errors are not absorbing information well, not understanding the transformation of the problem, not following the material thoroughly, and weak mathematical comprehension of concepts. The mastery of the concept understanding ability indicator aligns with the results of the fraction knowledge formative test presented in Table 3.

Table 3. Summary of Daily Fraction Knowledge Assessment Results

Category	Cycle I	Cycle II
Highest Score	90	90
Lowest Score	65	75
Average Score	74	80
Total Completion	23 people	32 people
Percentage	71,875%	100%

The test scores obtained for the six research subjects are presented in Table 4.

Table 4. Recapitulation of Research Subject Scores

Initials	Category	Cycle I	Cycle II
U1	Upper	90	90
M1	Middle	75	80
L1	Low	65	75

Initials	Category	Cycle I	Cycle II
M2	Middle	80	85
L2	Low	65	75
U2	Upper	90	90

Based on the data in the table, it is evident that the CPA approach significantly enhances students' ability to understand concepts, particularly in the medium category, and has a substantial impact on students in the low category. The results of the analysis of the answers show that the CPA Approach helps students build a bridge of understanding from images to symbols. However, the improvement in conceptual understanding ability is not perfect because there are still obstacles in generalizing the concept of fractions to various problem contexts. The CPA approach is also highly effective for lower-level students, as it helps them understand concepts gradually, progressing from concrete to abstract concepts. There is a cognitive leap from the concrete to the pictorial, then partly to the abstract. The CPA approach provides a framework that conceptually helps students to form meaningful relationships between abilities at concrete, semi-concrete, abstract levels (Asfara, F., Fitri, H., Rusdi, R., & Aniswita, 2022). Thus, it can be said that the CPA approach can play a crucial role in testing the ideas that emerge, even from students with low academic categories. By referring to the criteria for completing learning objectives (KKTP) with a score of 75, there was an increase in the percentage of completeness between Cycle I and Cycle II.

CONCLUSION

Based on the implementation of the Concrete-Pictorial-Abstract approach, it can be concluded that in learning fraction material, the CPA (Concrete-Pictorial-Abstract) approach is carried out using visual and physical aids to help children understand abstract concepts. This approach is based on children's existing knowledge by introducing abstract concepts in a concrete and real way. By following the steps of the CPA approach correctly, students' conceptual understanding abilities show good results and increase.

Based on the study's results, the CPA Approach can be recommended and applied by mathematics teachers not only to fraction material, but also to other materials related to the concept. Further research is needed regarding efforts to minimize student errors in the concept understanding ability indicator.

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