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Enhancing Elementary Students' Numeracy Skills Through The Concrete Pictorial Abstract (CPA) Approach

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Abstract

This study investigates the impact of the Concrete-Pictorial-Abstract (CPA) method on fifth-grade students' SDN Cipayung 02 numeracy skills. In response to low numeracy performance on national examinations such as PISA, TIMSS, and Indonesia National Assessment Programme, as well as classroom observations emphasizing standard teaching approaches' limitations, this study investigates CPA as an alternate instructional strategy. The study used a posttest-only control group structure and a quasi-experimental methodology. Two randomly chosen classes make up the sample; one is the experimental group, and the other is the control. Data were obtained by testing, and the Independent Sample T-Test in SPSS Version 29 was used for analysis. Higher post-test scores in the experimental group (mean score of 70.32) than in the control group (mean score of 45.86) demonstrate that the CPA strategy significantly enhances students' numeracy skills when compared to traditional teaching approaches. The CPA technique, which goes through concrete, pictorial, and abstract stages, promotes a stronger mental understanding and practical application of mathematical principles. This study emphasizes the CPA approach's effectiveness in promoting numeracy literacy and suggests its widespread implementation in mathematics instruction. This study shows that CPA can be applied in mathematics learning by gradually using concrete objects, images, and symbols to improve students' understanding. Teachers need to be trained in using CPA through professional training and developing more interactive teaching modules. Numeracy assessments should also be adapted to problem-based formats and visual representations to suit this approach better. Education policies can adopt CPA in the national curriculum to improve numeracy literacy and international assessment results.

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INTRODUCTION

In order to meet the problems of modern life, students in the twenty-first century are expected to be able to grasp the qualities of competence, literacy, and character (Ate & Keremata Lade, 2022). Character development is crucial because it determines how individuals interact with society, uphold ethical values, and build resilience in facing challenges (Kemdikbud, 2022). Competence and character are essential for allowing students to use their knowledge in practical contexts. Competence bridges the gap between theoretical learning and practical application, ensuring that students are not just passive recipients of information but active problem-solvers in their respective fields (González-Salamanca et al., 2020). Literacy is often considered the most urgent among these three essential skills because it is the foundation for character and competence. Success in mastering these life skills depends on strengthening literacy that supports critical thinking, reasoning, and problem-solving skills (Yuningsih et al., n.d.).

The capacity to obtain, comprehend, and use knowledge intelligently is known as literacy (Keefe & Copeland, 2011; Ng et al., 2021; Rosita et al., 2023). The government has established six fundamental literacy skills recognized by the World Economic Forum through the National Literacy Movement (GLN): literacy, numeracy, science, digital, finance, and literacy culture and citizenship, which refers to the capacity to obtain, comprehend, and apply knowledge information wisely (Nabila & Suryaningsih, 2023). In today's rapidly evolving world, literacy is essential for individuals to engage critically with information, solve problems, and make informed academic, professional, or everyday decisions. The ability to process and use information efficiently determines one's capacity to thrive in an era dominated by digital advancements and an increasing data flow.
The World Economic Forum has established six fundamental literacy skills the government has established through the National Literacy Movement (GLN): reading, numeracy, scientific, digital, financial, and cultural and civic. These six forms of literacy are designed to equip individuals with the necessary skills to navigate the complex demands of the 21st century. Basic literacy refers to the ability to read, write, and comprehend texts, serving as the foundation for acquiring further knowledge and developing higher-order thinking skills. Numeracy literacy involves understanding and applying mathematical concepts to analyze data, solve problems, and make logical decisions in real-life situations. Engaging with scientific concepts, assessing evidence, and applying scientific reasoning to daily life and decision-making processes are all made possible by scientific literacy. Understanding online communication, cybersecurity, and the moral application of digital tools are all part of digital literacy, which is the capacity to navigate, evaluate, and use digital technologies. Financial literacy focuses on managing personal and financial resources wisely, understanding economic principles, and making informed financial decisions. Lastly, cultural and civic literacy involves understanding social

norms, cultural diversity, civic responsibilities, and democratic principles, fostering active participation in community and national affairs (Ng et al., 2021). One literacy that focuses on thinking and reasoning skills is numeracy literacy. By mastering numeracy literacy, students can relate the mathematical concepts they learn to real-life situations while supporting critical analysis and problem-solving skills outside of the context of mathematics (Dewayani, 2021; Nizaar & Maryani, 2023).

The capacity to comprehend, analyze, apply, and communicate fundamental mathematical ideas and principles in order to resolve issues in day-to-day life is known as numerical literacy (Bonifacci et al., 2021; De Lange, 2003; Seitz & Weinert, 2022). The ability to read and comprehend quantitative data displayed in various formats, including tables, graphs, diagrams, pictures, and more, is another aspect of this literacy. To put it simply, numeracy literacy is the capacity to use fundamental mathematical concepts in various contexts (Baharuddin, 2021). In social and state life, this numeracy literacy ability is essential, where information presented in the form of numbers, graphs, charts, and tables in every aspect of life is inevitable (Cohrssen & Niklas, 2019; Mahmud & Pratiwi, 2019; Seitz & Weinert, 2022).

Seeing the importance and indispensable need for numeracy skills in social life, people, especially students, should have good numeracy skills (Söğüt et al., 2021). Numeracy skills will help a person become more independent, confident, and competent in facing math challenges in daily life (Chan & Scalise, 2022). By mastering numeracy literacy, students can connect mathematical concepts with real-world situations, allowing them to analyze data, interpret patterns, and make wise choices in daily life (Seitz & Weinert, 2022). Numeracy literacy goes beyond basic arithmetic; it involves understanding numbers, logical reasoning, and applying quantitative skills to solve problems in diverse contexts, including finance, science, technology, and social studies (Nizaar & Maryani, 2023). This skill is essential for developing critical thinking, enabling students to assess information objectively and draw logical conclusions based on numerical evidence (Nabila & Suryaningsih, 2023).

Additionally, numeracy literacy fosters logical reasoning and cognitive flexibility, allowing students to apply mathematical principles beyond the classroom (Suryaningsih & Yarmi, 2023). It supports strategic thinking and decision-making, helping individuals recognize patterns, weigh different options, and predict possible outcomes based on quantitative data (She et al., 2018). For instance, understanding profit margins, budgeting, and cost analysis are key elements that rely heavily on numeracy skills in entrepreneurship. Similarly, in science and technology, numeracy literacy is fundamental for interpreting research findings, conducting experiments, and utilizing technological advancements effectively. Thus, numeracy literacy is not merely a skill confined to mathematics but a fundamental competency that enhances problem-solving, critical analysis, and decision-making in various aspects of life. Based on this, students with literacy numeracy skills will also strengthen their

abilities to think systematically and apply logic to real-world challenges, ensuring they can function effectively in a complex, data-driven world (Dewayani et al., 2021; Peters et al., 2006).

However, the reality on the ground is contrary to the above expectations. The findings of the Trends in International Mathematics and Sciences Studies (TIMSS), Indonesia National Assessment Programme, and Programme for International Student Assessment (PISA) examinations demonstrate that Indonesians have extremely poor numeracy abilities. Since 2000, Indonesia has participated in PISA and TIMSS under the *Organization for Economic Cooperation and Development* (OECD) (Dewayani, 2021). PISA is an assessment program conducted every three years to measure reading, math, and science skills in randomly selected 15-year-olds (OECD, 2019). On the other hand, TIMSS is a quadrennial evaluation program that aims to assess mathematics and science skills in grade IV elementary and grade VIII junior high school students (Prastyo, 2020). The Ministry of Education and Culture in Indonesia also administers a national assessment program called the Indonesia National Assessment Programme to evaluate fourth-grade elementary school pupils' proficiency in reading, arithmetic, and science.

Based on the 2022 PISA exam results, Indonesia scored 366 in maths, ranking 70th out of 81 nations. This score shows a decrease compared to the results 2018, where Indonesia achieved a mathematics score of 379 (OECD, 2023). Then, based on the results of the TIMSS mathematics test in 2015, Indonesia achieved a score of 397, which placed it 44th out of 49 countries. When viewed from the achievements of TIMSS from 1999-2015, Indonesia remains in the bottom 10 of all participating countries in the world (Prastyo, 2020). Meanwhile, data from the mathematics test results from the Indonesia National Assessment Programme 2017 shows that 77.13% of grade IV students lack mathematical skills (Atmazaki, 2017).

Preliminary research by researchers at SDN Cipayung 02 indicates that students' mathematical abilities are significantly low, as evidenced by their poor performance in the fifth-grader midterm exam. Most students scored far below the school's minimum competency standard, highlighting a widespread struggle with mathematics. One major cause of this difficulty is the students' lack of conceptual understanding, as they rely solely on formulas rather than grasping the underlying mathematical principles. As a result, when faced with application-based problems that differ from the examples given by their teachers, many students cannot solve them effectively. This suggests that students engage in rote memorization rather than meaningful learning, limiting their ability to apply mathematical concepts in different contexts. Moreover, the classroom learning process itself appears to contribute to students' struggles with mathematics. According to one of the homeroom teachers at the school, the mathematics teaching approach remains traditional, focusing heavily on formulas and repetitive problem-solving exercises rather than fostering conceptual understanding, critical thinking, or active

participation. Many students find mathematics difficult and uninteresting, leading to passive engagement and a lack of motivation in learning. This issue aligns with findings from previous research, which emphasize that a teacher-centered, procedural approach to mathematics negatively impacts students' ability to develop higher-order thinking skills (Bonifacci et al., 2021; Gal et al., 2020; Seitz & Weinert, 2022). Studies have shown that when students learn mathematics through memorization rather than conceptual exploration, their ability to transfer knowledge to new problems is significantly reduced.

In light of these findings, a shift in teaching approaches is necessary to improve students' mathematical abilities. Implementing inquiry-based learning, real-world problem-solving, and interactive instructional methods could enhance students' engagement and comprehension. Integrating numeracy literacy into different subjects, providing more opportunities for discussion, reasoning, and collaborative problem-solving, and moving away from a rigid formula-based approach are crucial steps toward fostering students' mathematical competence and critical thinking skills. From the results of these observations, it can be concluded that the teacher's approach also influences the low understanding of students in mathematics in the learning process. Mathematics learning is still focused on teachers *(teacher-centered)*, which means that the teaching process is primarily directed by the teacher, with students playing a more passive role. Seeing this, the researcher tried to apply an alternative learning approach that is suspected to improve students' numeracy skills, namely the CPA approach. The CPA approach effectively enhances numeracy skills by providing a structured progression from concrete experiences to abstract reasoning. It allows students to build a solid conceptual foundation rather than merely memorizing formulas or procedures (Azzumar & Juandi, 2023). Moreover, this approach accommodates different learning styles, ensuring that kinesthetic learners benefit from hands-on activities, visual learners from pictorial representations, and logical thinkers from symbolic reasoning (Shafiee & Meng, 2021). By fostering a deeper understanding of mathematical concepts, the CPA approach also boosts students' confidence in solving mathematical problems (Gunduz et al., 2022). Therefore, by implementing this approach, researchers aim to create a more engaging and effective mathematics learning experience that supports students in developing strong numeracy literacy skills.

The 1960 hypothesis of J. Brunner served as the foundation for the CPA approach (Putri, 2017). The CPA approach is an architectural approach to guide and develop students' understanding of mathematical concepts from something concrete to something abstract. Implementing this approach in learning activities starts from the concrete stage, which is the exploration of concepts by facilitating students through concrete experiences. Then is the pictorial stage, where the experience is represented as an image or diagram. After that, the abstract stage

expresses the previous image or diagram in an increasingly abstract form and closer to technical language or mathematical symbols (Tan et al., 2021).

Through learning phases that start with using manipulable, concrete objects, the CPA technique can help students develop a profound understanding. Students are encouraged to observe, touch, feel, and explore the concrete objects provided at this stage. Direct interaction with concrete objects in the CPA approach allows learners to realize that mathematics is closely related to their daily lives (Asfara et al., 2022). Integrating the CPA approach is hoped to create more meaningful and relevant learning for students. The urgency of implementing the CPA approach in improving numeracy literacy skills lies in its ability to bridge the gap between abstract mathematical concepts and students' real-world experiences. Many students struggle with mathematics because they find it too abstract and disconnected from their daily lives. By providing a structured learning progression from concrete to pictorial and finally to abstract representations, the CPA approach helps students develop a stronger conceptual foundation, making mathematical principles more accessible and easier to understand. Moreover, numeracy is an essential skill that enables individuals to analyze, interpret, and apply mathematical knowledge in practical situations, such as financial decision-making, problem-solving, and data interpretation. Without a solid numeracy foundation, students may face challenges in comprehending and applying mathematical concepts effectively in academic and real-life contexts. Therefore, adopting the CPA approach is crucial to ensuring that students do not merely memorize formulas but also develop the ability to think critically, reason logically, and apply mathematics confidently. This study determined whether learning with the CPA approach affects students' numeracy skills.

METHODS

This study tested a treatment specifically, the application of learning using a CPA approach using a quantitative, quasi-experimental research design. A posttest-only control group design is the study methodology employed. The experimental group used learning with the CPA approach, while the control group used learning with a scientific approach. After being treated in both classes, students were given a test at the end of learning to see if the CPA approach affected numeracy skills.

The population in this study consists of all Grade V students at SDN Cipayung 02 for the 2023/2024 school year. The sampling method used is Cluster Random Sampling, where entire classes are randomly selected to serve as the experimental and control groups. Based on this technique, two classes were chosen as research samples: Class V-D as the experimental group and Class V-C as the control group, with each class comprising 32 students. The selection of Class V-D as the experimental group and Class V-C as the control group was based on ensuring

homogeneity and fairness in the study. Both classes were chosen because they have similar academic abilities, learning environments, and teacher instruction methods, ensuring that differences in results can be attributed to the intervention (CPA approach) rather than external factors. Additionally, these classes were selected randomly within the Grade V population to reduce bias and increase the reliability of the study's findings. By applying the CPA approach to Class V-D and maintaining traditional teaching methods in Class V-C, this study aims to assess the effect of the CPA approach on students' numeracy literacy skills in a controlled and measurable manner.

Tests and documentation are used in this study to collect data; the test questions assess students' numeracy skills using up to six description questions that have been verified for validity and reliability. The six items measure three indicators of numeracy ability: 1) analyzing information on building space problems presented in different formats, 2) using different types of numbers or symbols related to basic mathematics to solve problems in daily life, and 3) interpreting the analysis's findings to forecast and make decisions (Kemdikbud, 2017). On the other hand, documentation is secondary data in the form of odd-semester students' PTS scores in mathematics. With the aid of the IBM SPSS Statistic Version 29.0 tool, a T-test with an Independent Sample T-Test was used to analyze the data.

RESULTS

Using the IBM SPSS 29.0 application, the average difference in the numeracy ability test between the experimental and control classes was analyzed using the t-test stage, yielding the following results.

Table 1. Results of the Independent Sample T-Test Hypothesis Test

		t-test for Equality of Means			
				Significance	
		T	Df	One-Sided p	Two-Sided p
Nilai siswa	Equal variances assumed	4,914	54	,001	,001
	Equal variances not assumed	4,914	53,970	,001	,001

It is evident from Table 1 that the two-sided p (sig) value is 0.001. Hypothesis tests are used to make judgments. If the sig value is greater than 0.05, then H0 is accepted; if it is less than 0.05, then H0 is rejected. Thus, it can be said that there is a difference in the average score between the experimental and control groups because the value of sig. < 0.05 indicates that H0 is rejected and H1 is approved. Consequently, the application of the CPA technique affects pupils' numeracy abilities. Additionally, the following information is displayed in the descriptive statistical SPSS output:

Table 2. Descriptive Statistical SPSS Output Results

Descriptive Statistics						
	N	Range	Min	Max	Mean	Std. Deviation
Post-Test Eksperimen	28	63	37	100	70,32	18,844
Post-Test Kontrol	28	63	16	79	45,86	18,406
Valid N (listwise)	28					

The experimental class's average numeracy ability, as determined by the data in Table 2, is 70.32, more significant than the control class's average of 45.86. This suggests that children who receive instruction using a physical, visual, or abstract method have a stronger numeracy ability than students who receive instruction using scientific approaches.

The results of the numeracy ability test data in the experimental and control classes are seen from each of the numeracy ability indicators used in this study, which are as follows.

Table 3. Comparison of Numeracy Ability of Experimental Class and Control Class

Numeracy Ability Indicator	Eksperimen			Control		
	Max score	$\bar{x}$ Student Score	%	Max score	$\bar{x}$ Student Score	%
Analyse information on issues related to building space presented in various forms	8	6,7	84%	8	6,3	79%
Using a wide variety of numbers or symbols related to basic mathematics in solving everyday life problems	8	4,8	60%	8	2,1	27%
Interpret the results of analysis to predict and make decisions	8	5,3	67%	8	2,5	31%

According to Table 3, the experimental class achieved an achievement percentage of 84% in the first indication, compared to 79% for the control class. This demonstrates that the experimental class's capacity to analyze student data is superior to that of the control group. The experimental class then received a 60% percentage in the second indicator, compared to 27% for the control class. This shows that the ability to use mathematical numbers and symbols in solving problems in the experimental class is better than that of the control class. Additionally, the experimental class received a 67% percentage in the third indicator, compared to 31% for the control class. This demonstrates that the experimental class outperforms the control class in interpreting the

analysis's findings to forecast and make judgments. Overall, the experimental class employed pictorial, abstract, and concrete approaches outperformed the control group.

DISCUSSION

The study results show that the CPA approach influences the numeracy ability of grade V students of SDN Cipayung 02. Many factors contribute to the experimental class pupils' superior numeracy proficiency scores. First, by using the CPA approach in the classroom, students actively participate in developing a thorough comprehension of subjects. During the concrete stage, children are taught to develop their comprehension of the topics they have learned through hands-on exercises with tangible things. This is consistent with the findings of Suryaningsih's study, which shows that children can better grasp mathematical ideas and numeracy literacy skills with the use of real media (Suryaningsih et al., 2023).

Students then use pictures to represent information in the pictorial stage. Using the pictorial stage, students are trained to model mathematical ideas from concrete to semi-concrete. Students are allowed to solve a particular problem by drawing at this stage, allowing them to practice grasping concepts. The picture depicts a tangible item that students work with to solve an issue during the concrete stage *(*Putri, 2017*)*.

Additionally, the final step, the abstract or "symbolic" stage, consists solely of solving mathematical problems with symbols and numbers. At this stage, students are instructed to solve issues in mathematical or abstract forms, so they are used to providing logical, mathematical justifications for their solutions. An illustration of the outcomes of student work at the abstract level is provided below (Putri, 2017).

Second, learning with the CPA approach makes it easier for students to build connections between what they see and manipulation with more abstract mathematical symbols and formulas. These connections are important for improving numeracy skills, as students can apply abstract concepts in various contests. This is consistent with the statement made by Wittzel (2005), who proposed that the CPA approach is a three-phase learning process that starts with manipulable tangible objects. The final step employs abstract notation, such as symbols and numbers, while the subsequent level uses pictures that depict tangible items from the earlier stage. It has been shown that guiding children through these three phases is beneficial, particularly for those who struggle with math.

Radiusman and Simanjuntak (2020) found that the mathematical representation ability of students taught with the CPA approach was better than that of students taught with conventional learning. Selain itu, Yuliyanto et al. (2019) also showed that students who were taught using the CPA approach experienced an improvement in their learning outcomes. This is in line with Asfara et al. (2022), who concluded that the understanding of mathematical concepts of students who participated in learning with the CPA approach was higher than that of students who participated in conventional learning. Therefore, previous studies that examined the influence of the CPA approach found that the CPA approach can indeed affect students' numeracy skills.

According to the presentation's findings, the learning process employing the CPA technique has been shown to enhance students' numeracy abilities. Along with improving exam scores, children become more engaged and self-assured in the classroom. Students will become accustomed to addressing problems that apply to everyday life by using the

CPA technique, which will aid in their ability to analyze data, solve problems, and make wise judgments.

CONCLUSION

This study shows that the CPA approach significantly affects the improvement of the numeracy ability of grade V students at SDN Cipayung 02, especially in the building materials of cube and block spaces. The results of data analysis revealed that students who participated in learning with the CPA approach had a higher average post-test score (70.32) than students who were taught using conventional methods (45.86). The CPA approach, which consists of concrete, pictorial, and abstract stages, helps students develop a deeper understanding of concepts and apply mathematics in real-world contexts. In addition, this approach also increases students' active participation in the classroom, trains analytical skills, and supports better decision-making. Thus, the CPA approach is recommended as an alternative learning method to improve students' numeracy literacy in primary education.

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