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Concrete - Pictorial - Abstract Approaches to Mathematics Education: A Systematic Literature Review

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Abstrak: Penelitian ini merupakan penelitian sistematik literatur review (SLR) yang berfokus pada implementasi pendekatan CPA dalam pendidikan matematika. Penelitian ini bertujuan untuk melihat pandangan yang lebih mendalam dan komprehensif tentang implementasi pendekatan CPA dalam pendidikan matematika dilihat dari tahun penelitian dan jenjang Pendidikan. Artikel penelitian yang dikumpulkan dan dianalisis berjumlah 20 berdasarkan kriteria inklusi dan ekslusi yang dsudah ditetapkan. Selama periode 2018 sampai 2022 ditemuan bahwa implementasi pendekatan CPA terhadap hasil belajar matematika, kemampuan matematika siswa, kemampuan afektif siswa paling banyak dilakukan pada jenjang SD. Implementasi pendekatan CPA pada jenjang SMP sudah dilakukan, namun masih sedikit. Pada jenjang SMA paling sedikit dilakukan, hanya ditemukan 2 artikel yang menggunakan subjek siswa SMA. Secara keseluruhan pendekatan CPA meningkatkan hasil belajar matematika, kemapuan matematika, dan kemampuan afektif siswa di setiap jenjang Pendidikan.

Kata kunci : *pendekatan concrete-pictorial-abstract, pendidikan matematika, hasil belajar matematika, kemampuan matematika, afektif siswa*.

Abstract: This research is a systematic literature review (SLR) research that focuses on the implementation of the CPA approach in mathematics education. This study aims to look at a more in-depth and comprehensive view of the implementation of the CPA approach in mathematics education in terms of the year of research and level of education. There were 20 research articles collected and analyzed based on predetermined inclusion and exclusion criteria. During the period 2018 to 2022 it was found that the implementation of the CPA approach to mathematics learning outcomes, students' mathematical abilities, students' affective abilities was mostly carried out at the elementary level. The implementation of the CPA approach at the junior high school level has been carried out, but it is still small. At the high school level, at least it was carried out, only 2 articles were found that used high school students as subjects. Overall the CPA approach improves students' learning outcomes in mathematics, mathematics ability, and students' affective abilities at every level of education.

Keywords: *concrete-pictorial-abstract approach, mathematics education, mathematics learning outcomes, mathematical abilities, student affective*.

INTRODUCTION

Mathematics education is one of the main focuses in the global education system. Even though various efforts have been made to improve the quality of learning mathematics, there are still many

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students who experience difficulties in understanding mathematical concepts (Yunarti: 2020). One approach that can be used to help students understand mathematical concepts is the CPA (Concrete-Pictorial-Abstract) approach.

According to (Putri: 2015) this approach allows students to build an understanding of mathematical concepts gradually, from concrete to abstract experiences. According to (witzel: 2003) the CPA approach can help students overcome difficulties in learning mathematical concepts in learning. The Concrete-Pictorial-Abstract (CPA) approach has become a popular approach in learning mathematics, especially in teaching basic mathematical concepts such as numbers, operations, and fractions. According to (Flores: 2010) the CPA approach is effective in learning number operations.

The CPA approach enables students to build a better understanding of concepts by using visual, concrete, and abstract representations. Mosely (Croix, 2017) This approach can help students to associate mathematical representations with the real world and deepen their understanding of these concepts. (Mancl, Miller & Kennedy: 2012) The CPA approach can help students build a better understanding of concepts by use visual representations, from the concrete to the abstract. Although there has been much research on the effectiveness of the CPA approach in learning mathematics, there are still differences in the way these approaches are implemented and their effectiveness depending on context and other factors. Therefore, it is necessary to carry out systematic and comprehensive research to understand more broadly the effectiveness of the CPA approach in mathematics education.

Many studies have explored the effectiveness of the CPA approach in mathematics education. research conducted by Yuniarti, Suryadi, and Setiawan (2018) regarding the effect of the CPA approach on elementary school students' understanding of mathematical concepts. Their research results show that the CPA approach significantly improves students' understanding of mathematical concepts. In addition, research conducted by Zhang, Ding, and Wang (2019) also shows that the CPA approach can improve students' mathematical problem solving skills at various levels of education. In addition, other studies also show that the CPA approach can help students build a better understanding of mathematical concepts, increase learning motivation, and increase students' confidence in learning mathematics.

Although much research has been done on the effectiveness of the CPA approach, there are still differences in the way these approaches are implemented and their effectiveness depending on context and other factors. Therefore, systematic and comprehensive research is needed to understand more broadly the effectiveness of the CPA approach in mathematics education. Literature Systematic Review (SLR) research can provide a more in-depth and comprehensive view of the effectiveness of the CPA approach in mathematics education. This SLR research can also provide useful recommendations for practitioners and researchers in the field of mathematics education in teaching and further research.

RESEARCH METHOD

The research method used in this research is Systematic Literature Review (SLR). According to Juandi (2021) SLR has the goal of synthesizing research results as a whole based on specific questions, using regular, clear, and replicable procedures at each stage of the process. In line with research (Triandini 2019), using this method a review and identified journals systematically in each process following the steps that have been determined.

Triandini (2019) explains the steps in SLR as follows: (1) Research Questions or research questions, created based on the topic chosen by the researcher. (2) Search Process or search process, used to get answers to research questions in the previous step obtained from relevant sources. (3) Inclusion and Exclusion Criteria, at this stage a decision is made whether or not the data used in SLR research is appropriate. (4) Quality Assessment, at this stage the data that has been found will be evaluated based on the criterion questions in the predetermined quality assessment. (5) Data Collecting or data collection is the stage where existing research data is collected. And (6) Data Analysis, at this stage the data that has been collected will be analyzed to show the results of the research questions that have been made before and conclusions are drawn.

Questions in the research include:

1. What is the description of the implementation of the CPA approach to student mathematics learning outcomes in terms of research year and research level?
2. What is the description of the implementation of the CPA approach to students' mathematical abilities in terms of the year of research and the level of research?
3. What is the description of the implementation of the CPA approach to Attitudes mathematics in terms of research year and research level?

The data search process uses journal databases such as Google Scholar, Eric, and Sage Journals. The keywords used are the CPA approach to mathematics education, CRA mathematics education, CRA approach mathematics education. Articles found based on the appropriate keywords are more than 100.

In this study the inclusion criteria were used, including:

1. research that applies the CPA approach to learning mathematics.
2. research conducted on elementary, junior high and high school students of the same level.
3. research published in official journals or conferences either nationally or internationally which have a peer-review process.
4. Research carried out in the last 5 years or in the period 2019 to 2022.
5. The databases used are Google Scholar, Eric, and Sage Journals.

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In this study, exclusion criteria were also used, including:

1. research that does not apply the CPA approach in learning mathematics.
2. research conducted on college students.
3. research published in the repository
4. Research conducted before 2018
5. Research on students with special needs

In the next stage is the quality assessment process, where this process aims to select and evaluate articles so that articles that comply with the predetermined inclusion and exclusion criteria are obtained. Found more than 100 articles that fit the research keywords, but only 24 articles met the criteria for further analysis. The next stage is data collection and data analysis process where articles that meet the criteria are analyzed in order to obtain comprehensive knowledge according to the research topic.

RESULTS AND DISCUSSION

The results of the research presented are the results of an analysis of research that has been conducted regarding the CPA approach in mathematics education that meets predetermined inclusion and exclusion criteria. The following table presents an overview of the characteristics of the results of research on the CPA approach in mathematics education.

Table 1. Research Data

Characteristics	Variation	NA	LO	AA	C
Research year	2018	2	1	1	1
	2019	6	1	2	4
	2020	6	2	1	3
	2021	4	1		3
	2022	2			2
Educational level	Elementary School	14	3	3	9
	Junior High School	4	2	1	2
	Senior High School	2			2

Note: NA=Number of article; LO=Learning outcomes; AA= Affective Abilities; C=Cogntive/Mathematical competence

1. The Implementation Of The CPA Approach To Student Mathematics Learning Outcomes Is Seen From The Research Year And Research Level

With a total of 20 articles collected and analyzed from 2018 to 2022, 5 articles were obtained regarding the implementation of the CPA approach to student mathematics learning outcomes. The following is presented in the form of a diagram.

Figure 1. Diagram of The CPA Approach to Improving Mathematics Learning Outcomes by Year and School Level

Based on Figure 1, it can be seen that from the period 2018 to 2022 research related to the implementation of the CPA approach to student learning outcomes was carried out 5 times. In 2022 no research on the implementation of the CPA approach to learning outcomes will be carried out. In 2020 the most research was carried out, namely 2 times, namely at the elementary and junior high school levels. During the period 2018 to 2022 most research related to the implementation of the CPA approach to student learning outcomes was conducted on elementary school students. For the high school level, research has not been carried out at all. While research at the junior high school level was conducted 2 times, namely in 2018 and 2020.

At the senior high school level, the approach to learning mathematics is more focused on understanding more abstract material concepts and their more complex applications. Based on Ball, Thames, & Phelps (2008) states that the mastery of mathematical concepts in high school is more abstract, so it is important to choose the right learning approach to help students understand the abstract concepts of mathematical material. So many think that the CPA approach which emphasizes concrete experience is less relevant to abstract high school material. Thus there is still little research on the CPA approach to improving student learning outcomes at the senior high school level.

2. The Implementation Of The CPA Approach To Students' Mathematical Abilities Is Seen From The Year Of Research And Research Level

With a total of 20 articles collected and analyzed from 2018 to 2022, 12 articles were obtained regarding the implementation of the CPA approach to students' mathematical abilities. Of the 12 articles, there were 13 students' mathematical abilities studied. The following is presented in the form of a diagram

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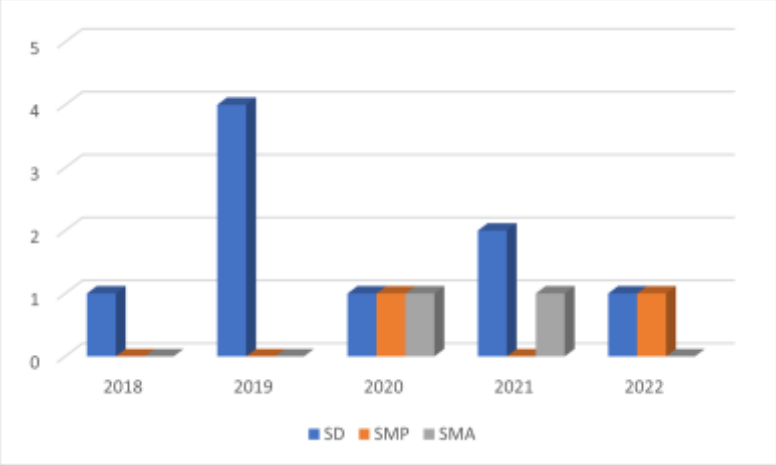

Figure 2. Diagram of The CPA Approach to Improving Mathematics Competence by Year and School Level

Based on Figure 2, it can be seen that from the period 2018 to 2022 research related to the implementation of the CPA approach to mathematical ability was carried out 13 times. Where in 2019 was the most researched, namely 4 students' mathematical abilities. 2018 was the lowest year, namely only 1 study of elementary school students. During the period 2018 to 2022, most of the research related to the implementation of the CPA approach to students' mathematical abilities was conducted on elementary school students. For research at the junior and senior high school levels, little has been done. Research at the junior high school level was conducted 2 times, namely in 2020 and 2022. Research at the high school level was conducted 2 times, namely in 2020 and 2021.

The CPA approach is mostly carried out at the elementary school level because elementary school age is still in a concrete cognitive development stage. In line with Bruner (Siregar & Hartini: 2014) who said the early stage of children's cognitive development is the enactive stage. The enactive stage is the stage where children learn concepts through real objects or experience events around them. So that children with elementary school level will prefer physical activities. In addition, the SD level is a period when students learn about basic mathematical concepts such as numbers, arithmetic operations, and basic geometry. So that the CPA approach is mostly carried out in elementary schools because by utilizing real objects, physical activity, and direct experience can gain deeper knowledge about the concepts of the basic math material.

Mathematics material at the high school level is already a lot in abstract form. In line with Anderha & Maskar (2020) states that in high school mathematics there are theorems and abstract forms. So it is not easy to be represented visually in form which is easier for students to understand. However, it is precisely abstract concepts that can be difficult for students to understand if they are started with concrete experiences that will be easier for students to understand. Based on Putri (2017) a CPA approach that

can represent abstract material into concrete visuals will have the opportunity to build a deeper understanding of the concept gradually. However, in this case it is hoped that further researchers will be able to conduct research on the implementation of the CPA approach to the mathematics abilities of junior and senior high school students. By taking materials that can be visualized with real objects or with direct experience-based learning.

3. The Implementation Of The Cpa Approach To Student Affective Was Seen From The Year Of Research And Research Level

With a total of 20 articles collected and analyzed from 2018 to 2022, data obtained regarding the implementation of the CPA approach to student affective totaled 4 articles. The following is presented in the form of a diagram

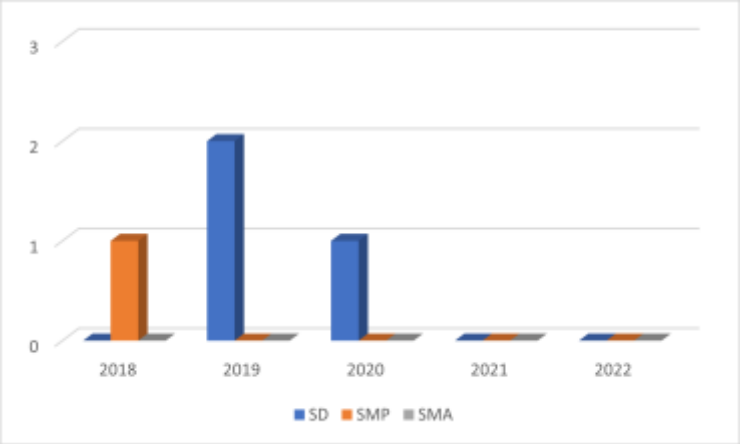

Figure 3. Diagram of The CPA Approach to Student Affective by Year and School Level

Based on Figure 3, it can be seen that from 2018 to 2022 research related to the implementation of the CPA approach to students' affective abilities was carried out 4 times. The most research was conducted in 2019, namely 2 times on elementary school students. In 2021 and 2022 no research will be conducted at either the elementary, middle or high school levels. During the period 2018 to 2022, most research related to the implementation of the CPA approach to students' affective abilities was conducted on elementary school students. For the high school level, research has not been carried out at all. While research at the junior high school level was conducted 1 time, namely in 2018.

Learning with the CPA approach allows students to be actively involved in the learning process. Through the use of manipulatives, pictures, and physical activity directly make learning more interesting, especially for elementary school students. Based on Putri & Muqodas (2019) by starting from concrete experiences and visual representations that are easier to understand, students feel more involved and confident in dealing with mathematical material. A more concrete approach can reduce the pressure on

students in learning math concepts. Thus it can help increase learning motivation, increase self-efficacy abilities, and reduce students' math anxiety.

CONCLUSIONS AND SUGGESTIONS

Based on the results and discussion of the research, it was found that the implementation of the CPA approach to learning outcomes, students' mathematical abilities, students' affective abilities was mostly carried out at the elementary level. Of the 20 articles that met the inclusion criteria, at the elementary level the CPA approach was mostly used to see the implementation of students' mathematical abilities. The implementation of the CPA approach at each junior high school level towards improving learning outcomes, students' mathematical abilities, and students' affective abilities has been carried out, but it is still small. For the implementation of improving learning outcomes and students' mathematical abilities each was carried out 2 times during the period 2018 to 2022.

Meanwhile the implementation of students' affective abilities was carried out only once. At the high school level, little is done. Of the 20 articles that met the inclusion criteria, only 2 articles were found using high school students as subjects. Research on the CPA approach at the high school level was found to be only carried out for the implementation of students' mathematical abilities. For the implementation of the CPA approach to improving student learning outcomes and affective abilities has not been done. It is hoped that future researchers can conduct research on the implementation of the CPA approach to students' mathematical and affective abilities in high school students

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