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# The Effect of *Concrete-Pictorial-Abstract* (CPA) Approach on The Decrease of Mathematical Anxiety in Primary School

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**Abstract.** Mathematics is still regarded as a difficult subject that promotes students' anxiety. The aim of this study is to investigate the effect of *Concrete-Pictorial-Abstract* (CPA) approach on the decrease of students' mathematical anxiety in primary school. This study use Research and Development (RnD) **model** which includes descriptive, experimental and evaluative methods. Experimental method was used to identify the effect or the efficacy of CPA approach implementation on the decrease of students' mathematical anxiety. The subjects of this study were 131 fifth grade students in two different primary schools in Subang and Karawang, West Java. The lesson was implemented by assigning students into two groups: (1) students who experienced learning with *Concrete-Pictorial-Abstract* (CPA) as experimental group and (2) students who experienced learning with convensional method as control group. Inferential data analysis suggests the significant effect of *Concrete-pictorial-Abstract* (CPA) implementation on the decrease of students' mathematical anxiety in primary school. This evidence is supported by the calculation of determinant test which imply high percentage of *Concrete-Pictorial-Abstract* (CPA) effecton the decrease of students' mathematical anxiety in primary school. Therefore, instruction with CPA can be used as an alternative solution to reduce mathematical anxiety of students in primary school.

**Keywords:** *Concrete-Pictorial-Abstract* (CPA), mathematical anxiety, primary school students

**INTRODUCTION** ~ Mathematics is a subject that is taught since early years as it is essential for living. In Indonesia, Mathematics is formally taught in kindergarten until higher education or university. Currently many teachers teach mathematical materials using conventional approach, thus making the learning process seems to be rigid and boring. Moreover, such instructions make students perceive mathematics as a subject that is difficult to understand and frightening. This condition is contrary with the aims of competences in mathematics subjects of primary levels (grade 1 to 4), which includes: (1) demonstrate positive mathematical attitudes: logic, accurate and careful, honest, responsible and persevere in solving problems as the implementation of habits in Mathematical inquiry and exploration; (2) curious, has continuous learning motivation, confidence and interest on mathematics which are construction on learning experiences; (3) open to differences of perspectives and express possible different point of views (Mendikbud, 2016).

Suarjana, Riastini, &Pustika (2017) suggest that students' are afraid of mathematics because the way they understand the material is not appropriate, especially in the beginning of the lesson. Students' fear on mathematics is called as mathematical anxiety. Anxiety appears as someone is in particular threatening situation. The same thing applies on children, where students might have high mathematical anxiety due to their prior experiences on

mathematics subject. Mathematical anxiety also can affect students' daily life, academic performance and even contribute to increase students' stress. When this condition continues, various problems might come out (Shishigu, 2018). Ramirez, et al. (2016) explain that mathematical anxiety is a problem that might give negative effect on learning achievement and job prospects in the future. The negative relationship among mathematical anxiety and learning achievement in mathematics is because mathematical anxiety leads students to avoid Mathematics subject and might disrupt students' performance in solving particular mathematical problems. In this condition, it is predicted that there is particular barrier that prevent knowledge transfer thus causing students difficult to understand the materials being learnt.One of the biggest barriers in mathematics learning is students who cannot understand the materials presented in abstract form. According to Aschraft and Moore (Carey et al., 2017, p. 2) mathematical anxiety includes fear,tension and discomfort emotions felt by several individualsregarding mathematics and might interfere one's performance in doing mathematics.

Tobias andWeissbrod (Sofiatun, Sampoerna, and Hakim, 2018) describe mathematical anxiety as panic, helplessness, paralysis, and mental disorders that arise when solving Mathematical problems. Annisa and Ifdil (2016, p. 94) also describe anxiety as emotional condition when someone has discomfort feelings, and is a vague experience accompanied by feelings of helplessness and uncertainty caused by an uncertain thing. Therefore, mathematical anxiety can be defined as uncomfortable feelings arising from unstable emotional conditions that are characterized by fear, worriedness, anxiety, panic, etc. when facing an unwanted task.

Cavanagh andSparow (2010a) divide mathematics anxiety into 3 domains, those are: 1) *somatic*; 2); *cognitive*and 3) *attitude*. Each domain was further divided into three levels of mathematical anxiety (high, medium and low) which is presented in Table 1.

**Tabel 1.** Aspects, levels and indicators of mathematical anxiety

| No. | Aspect | Level of mathematical anxiety | Indicator |
|---|---|---|---|
| 1. | *Attitudinal* | High | afraid of what being done |
| | | Medium | Has no intention to do things that should be done |
| | | Low | Expecting difficulties in doing particular thing |
| 2. | *Cognitive* | High | Worry of being judged by others that she/he cannot do things well |
| | | Medium | Has an Empty mind |
| | | Low | Feeling confused |
| 3. | *Somatic* | High | Difficult to breath |

| | |
|---|---|
| Medium | Heart beating fast |
| Low | Feeling uncomfortable |

(Source: Cavanagh andSparow, 2010a)

TIMMS (2016) surveys on students in fourth grade primary school indicate that there were only23% students who have high confidence level. The average performance of these students is 440 placing Indonesia in bottom 8 out of 49 countries. Study done by Amelia (2011) involving 21 students in grade 3 primary school in Depok West Java, found that the average score of students' anxiety prior to the lesson implementation is 28.4%. Kristandi and Widyawati (2014, p. 55) explains that improper method in mathematics instruction could make students difficult to understand the materials being learnt, has negative experience during learning math, develop negative perspective toward mathematical things, and eventually resulting in mathematical anxiety. Sofiatun, Sampoerna, and Hakim (2018) describe that a contributing factor of mathematical anxiety is type of instructional method used by teacher. Appropriate method application can be in form of instructional approach that promote mathematical problem solving and decrease students' mathematical anxiety. Students prefer mathematics teacher who enable them to exploit their misunderstanding of particular mathematics concepts. Teacher's patience and connection with students will greatly affect students' success in learning mathematics. Therefore, mathematics instructions should change its image from mechanistic learning into enjoyable humanistic learning (Hendriana, 2012). Fun and enjoyable instruction could make the learning process more effective. In respond to this problem, one of the efforts that can be made is by applying the Concrete-Pictorial-Abstract (CPA) approach to Mathematics instruction.

Concrete-Pictorial-Abstract (CPA) approach is associated with learning stages explained by Bruner as each stage in CPA approach is rooted from Bruner's learning theory which includes enactive (concrete), iconic (pictorial) and symbolic (abstract) (Hoe & Jeremy, 2014;Hui, Hoe, & Lee, 2017). Furthermore, Bruner ((Hui, Hoe, & Lee, 2017) describe that learning is started from real experience (enactive). That experience will further be translated into picture of how the experience is formed (iconic). The final stage is translating the picture into mathematical notation (symbolic).Putri, et al. (2016, p. 45) explain that *Concrete-Pictorial-Abstract* (CPA) is an approach that could help student to construct deep concept about materials being learnt through instructional process that begins with the use of concrete things. Purwadi, Sudiarta, andSuparta (2019) added that a strategy used in CPA instructions is the stage of concrete object manipulation and the use of various object representations that could help students to decrease anxiety when they are dealing with abstract

concept. Putri (2017) explain the advantages of CPA approach that is the use of concrete objects as manipulative tool to help students in improving and developing their mathematical skills as well as fostering confidence in solving mathematical problems. Mosely (Croix, 2017) describes several benefits of CPA approach, which includes the use of concrete object that might help primary school students to understand mathematical concepts and problems. It is because concrete object can illustrate the problem since it can be moved, grouped and re-arranged. In addition, CPA approach also can foster self-confidence.

When child's understanding developed, they are encouraged to move to abstract representation stage. In this stage, children able to identify what she/he understands about the problem by using symbol in form of numbers or others symbol. Study done by Kristiani andPrasetyo (2016) also revealed that mathematics instruction that use concrete objects as learning media in primary school resulting positive respond. On the other hand, CPA approach which is used to help students who has difficulties in learning Mathematicsis found to be effective in recovering deficit of basic Mathematics calculations (Hoong, Kin, andPien, 2015).

Colham Manor Primary School & Children's Centre (2016) recognizes CPA approach as the mainstay of mathematics instruction in Singapore. In this country, CPA approach is included into mathematics syllabus for primary level. This is in line with the description of *Curriculum Planning and Development Division* (2012, p. 33) which indicate the improvement of conceptual understanding through instructions with *Concrete-Pictorial-Abstract* (CPA) in Singapore.

According to aforementioned background, this study comes to research question: "is there any effect of CPA approach application on the decrease of students' mathematics anxiety in primary school?". Furthermore, the expected hypothesis of this study is that there is an effect of CPA approach application on the decrease of students' mathematics anxiety in primary school. The hypothesis of this study is statistically written as follow:

$H_0$: $\mu_1 = \mu_2$. The application of CPA approach has no effect on the improvement of students' achievement.

$H_1$: $\mu_1 \neq \mu_2$. The application of CPA approach has effect on the improvement of students' achievement

**METHOD**

This study was implemented from November 2018 to May 2019. This study is a development research, therefore *Research and Development* (R&D) method is used. Gall and Borg (2010) define R&D as a systematic process to develop, improve and evaluate

educational program and materials. This definition implies that research and development in education are process of developing research product and further validate the product. In this study, research product that will be developed and validated is learningmaterials which are designed in such a way according to CPA approach. The product will also be used to measure spatial sense ability and mathematical anxiety of students in primary school. There are three methods used in R&D implementation which includes descriptive, evaluative and experiment (Ditjen PMPTK, 2008). In this study, the descriptive method is used to gather data about the needs of constructing learning materials which is adjusted to the stages of instruction with CPA approach, research instruments for spatial sense ability and mathematical anxiety of primary school students.

Furthermore, evaluative method is used to evaluate trial process of learning material development which is developed according to CPA approach to improve spatial sense ability and decrease mathematical anxiety of students in primary school.

On the other hand, experimental method used to test the efficacy of the product (DitjenPMPTK, 2008), which refers to learning materials that has been developed and instrument that has been tested. The learning materials and instrument that had been developed were tested during research implementation. The efficacy of the effect of learning materials and instruments that has been developed according to CPA approach is tested by using experimental method.

The experimental method which is used is quasi experiment with pretest (initial) and posttest (final) control group design. Ruseffendi (1998) illustrate this research design as follow:

O X O

O O

A = *Acak* (randomized sampling)

O = test of mathematical anxiety (pretest and posttest))

X = Mathematics instruction using CPA approach

This study used two groups that comprises of experimental group engaging in mathematics instruction using CPA approach and control group engaging in mathematics instruction with conventional method. This study involved 131 primary school students in Subang and Karawang, West Java Indonesia. 66 students engaged in instructions with CPA approach while 65 students engaged in conventional instruction. The sample were chosen using purposive sampling technique. The sample werechosen according to particular consideration such as: 1) the students are fifth grader. It is because in this phase students are about 10 to 11 years old and still in concrete operational stage. Therefore according to Piaget learning

theory, children in this stage develop their thinking through concrete objects; 2) the study did not interfere school program in preparing for final examination.

Data analysis used in this study is inferential analysis in form of linear regression test and calculation of determinant coefficient. Calculation of determinant coefficient is used to analyze the percentage of effect that X variable (instructions with CPA approach) has on Y variable (students' mathematical anxiety)

**RESULTS**

The effect of CPA approach implementation on students' mathematical anxiety can be measured using simple linear regression test. Simple linear regression test used in this study aims to identify to what extend the application of CPA approach give effect on the decrease of students' mathematical anxiety. The following section will further describe the steps done in simple linear regression test.

Equation of Simple Linear Regression

The first step which is done is to determine the equation of simple linear regression. The common equation of simple linear regression is

$$\hat{Y} = a + \beta X$$

Where:

$\hat{Y}$= dependent variable

a = constant

β = regression coefficient

X = independent variable

The following table presents the equation of simple linear regression.

**Table 2.** Recapitulation of Constant and Coefficient for Equation of Simple Linear Regression

| Model | *Coefficients* | |
|---|---|---|
| | ***Unstandardized B*** | ***Coefficients Std. Error*** |
| *Constant* | -2,234 | 4,230 |
| Mathematical anxiety | 0,972 | 0,087 |

(Source: Research data, 2019)

From table 2, it can be seen that the constant value (a) is -2,234 and regression coefficient (β) is 0,972. The a value implies that if there is no treatment (instructions with CPA approach)then the value of students' mathematical anxiety is -2,234. On the other hand the β value implies that each addition of one unit of treatment with the CPA approach, the value of mathematical anxiety will increase by 0.972. From the calculation of constant (a) and regression coefficient (β) mentioned earlier it can be concluded that the equation of simple linear regression is $\hat{Y}$= -2,234 + 0,972X.

Significance Test of Simple Linear Regression

Significance Test of Simple Linear Regression is administered to identify the

significance of effect among two measured variables. The hypotheses are:

$H_0$: β = 0, regression is not significant.

$H_1$: β ≠ 0, regression is significant.

In this study, the required criteria used in simple linear regression so that the hypothesis can be accepted are as follow:

1) $H_0$is accepted if: *p-value* (Sig.) > a or 0,05
2) $H_0$ is rejected if: *p-value* (Sig.) ≤ a or 0,05

Table 3 present the results of Significance Test of Simple Linear Regression

**Table 3.** Recapitulation of Significance Test for Simple Linear Regression

| *Model* | *ANOVA* | | | | |
|---|---|---|---|---|---|
| | ***Sum of Squares*** | ***df*** | ***Mean Squares*** | ***F*** | ***Sig.*** |
| ***Regression*** | 2.540,149 | 1 | 2540,149 | 124,458 | 0,000 |

(Sumber: Penelitian, 2019)

As it can be seen from Table 3, $F_{calc}$for significance test of simple linear regression is 124.458 with *p-value (Sig.)* less than 0.05. This evidence fulfil the requirement to reject $H_0$, therefore it can be concluded that the regression equation $\hat{Y}$= -2.234 + 0.972X is significant.

Determine Determinant Coefficient

The calculation of determinant coefficient is meant to identify to what extend the instructions with CPA approach give effect on the decrease of students' mathematical anxiety. Prior to calculating determinant coefficient, the value of $R^2$ *(R Square)* should be found using simple linear regression test utilizing SPPS version 25. The results are presented on Table 4.

**Table 4.** Results of Determinant Coefficient Test

| ***R*** | ***R Square*** | ***Std. Error of Estimate*** |
|---|---|---|
| 0,813 | 0,660 | 4,518 |

(Source: Research data, 2019)

As it can be seen from Table 4, the value of *R Square* is 0,660. Once the R Square value is found, the determinant coefficient (D) can be calculated as follow:

D = $r^2$ x 100%

= 0,660 x 100%

= 66%

From the calculation above, it is found that the value of determinant coefficient (D) is 66%. This evidence suggests that CPA approach could give effect on the decrease of mathematical anxiety as much as 66%. Therefore, such effect caused by other factors is 100% - 66% = 34%.These percentage indicate that the application of CPA approach give significant effect on the decrease of students' mathematical anxiety.

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**DISCUSSION**

*Concrete-Pictorial-Abstract* (CPA) Approach.

Instruction with CPA approach in this study is designed to decrease mathematical anxiety of students in primary school.

The results of determinant coefficient calculation indicate significant effect of CPA approach on students' mathematical anxiety.

The success of instruction using CPA approach in decreasing students' mathematical anxiety found from this study is in line with study done by *American Institutes for Research* (Yuliawaty, 2011) which stated that students who are learning with concrete object has more appropriate and comprehensive development of mental representation; often more motivated and do the task well; comprehend mathematical ideas and are better on applying ideas to life situations.

Kristiani and Prasetyo (2016) also expressed that mathematics instruction using concrete object as media in primary school could improve the percentage of students passing the minimum score (KKM) determined by the teacher. Furthermore, the study done by Putri, Rahayu, Misnarti, andSaptini (2016) conclude that self-confidence fostered from previous experience can be improved by using CPA approach.

In pictorial stage, students were guided to represent concrete object into picture. In this stage students are said to understand the concept of concrete object that has been taught. Aside from representing concrete object into pictures, pictorial activity will be more complete of the students can be more creative by adding colors of concrete media that he/she draw. Wahyuningsih (2018) explains that coloring is a fun activity. Besides, coloring also train child's concentration and memory, thus can reduce the level of mathematical anxiety in medium level of attitudinal and cognitive aspects

Finding from observation revealed that coloring shapes can give pleasure for students. Students can express ideas through coloring activities. Moreover, the learning atmosphere is fun and joyful.

Abstract stage if the final stage of CPA approach. In this stage, mathematical concept is no longer presented using concrete objects or its pictures. Yet, mathematical concept is modeled in abstract way by using numbers or mathematical notation and symbols.

Appropriate conceptual understanding in abstract stage is constructed since concrete and pictorial stages. It is in accordance with Sousa (2007) who said that the use of abstract notation that refers to symbolic representations such as numbers or letters that students write or interpret, each were built in previous

lessons to improve conceptual knowledge and retention in Mathematics learning

However, sometimes there are several students who did not success in completing their task during abstract state. This is due to the students did not focus on paying attention to the materials explained by the teacher either in concrete stage, pictorial stage or both.

Unfocused behavior is one of mathematical anxiety indicator that includes into cognitive aspect in medium level. To solve this problem, Riccomini (Putri, 2015) suggests re-teaching concept or ability in concrete and pictorial stages as well as giving opportunity for students to use language to explain their solution and how they get the solution.

Students' Mathematical Anxiety

Linear regression test results indicate the effect of CPA approach application on the decrease of students' mathematical anxiety. This finding is supported by the result of determinant test where it is found that the application of CPA approach has significant effect on the decrease of students' mathematical anxiety as much as 66%. Similarly, relevant findings also expressed by Auliya (2017) who stated that students' mathematical anxiety is lower in group who experienced cooperative learning as compared to group who experienced conventional learning. Furthermore, Safitri (2016) also indicate the effect of games used in learning toward students' mathematical anxiety. Study done by Salingay and Tan (2018) found that the improvement of students' self-confidence who experienced CPA approach is better that those who did not experience instructions with CPA approach.

Self-confidence is actually developed from one of mathematical anxiety indicator in attitudinal aspect. Similarly, Hendriana (2012) suggests that self-confidence level of students who engaged in metaphorical thinking is better that students' who engaged in instructions with conventional method. Cooperative learning, realistic learning, metaphorical thinking approach and CPA approach is included into instruction applying constructivism theory.

## CONCLUSION

The application of *Concrete-Pictorial-Abstract* (CPA) approach has significant effect on the decrease of students' mathematical anxiety in primary school. The percentage of CPA approach effect on the decrease of mathematical anxiety is in high criteria. Thus, CPA approach can be used as one of alternative solution to reduce students' mathematical anxiety. The application of CPA approach on mathematics instruction able to change students' fear into pleasure feeling when they are learning mathematics.

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