The effectiveness of cognitive conflict on the concept of differential

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Abstract. This study aims to explore the effectiveness of learning with cognitive conflict approach seen from the first ability of students. This research method is quasi-experiment where there are two groups of a sample of class. Then in both levels are given pre-test and post-test, but the treatment is different that is given treatment with learning that uses cognitive conflict strategy and by applying ordinary learning. The subject of this research is the students of class XI IPA in Cimahi city. The results of the study show that cognitive conflict learning approaches are more effective in improving mathematical reasoning abilities. This is because in cognitive conflict approach students are more able to think critically. Students are directed to be able to solve problems in everyday life. The cognitive conflict learning approach is expected to be the teacher's choice to improve the ability of mathematical reasoning.

1. Introduction
Mathematics education has a significant role in the effort to create qualified human resources as capital for the development process. Through mathematics education is expected to add capabilities, develop skills and applications. In practice at school, mathematics needs to be packed and presented by the teacher to make it exciting and memorable for students. Mathematical reasoning is an integral part of mathematical learning. Through reasoning activities, students are expected to be able to develop his creative ideas, think logically, and can give conclusions in solving math problems especially in everyday life. There are four reasons why reasoning is essential in learning math and daily life, namely: 1) Reasoning is necessary to do math; 2) Reasoning is needed in mathematics lessons at school; 3) reasoning skills can be applied to other sciences; 4) Reasoning is useful for everyday life in other words reasoning can solve problems in daily life [1].

Currently, Indonesia has a complicated educational problem. One is the difficulty of students learning and understanding the mathematical material. This is demonstrated by the international comparison of the 2015 PISA (International Student Assessment Program) in mathematics that Indonesia is ranked 63 out of 70 countries with an average score of 386 [2]. The low learning achievement of mathematics is also demonstrated by the mastery of the mathematical material. As seen in the percentage of the National Examination, especially in one of the State Senior High School in Cimahi city in 2016. The average of the National Examination of Mathematics in SMA 65.34 is below the national average of 69.25. Based on the results of interviews with students, students feel that math, especially on the differential, is difficult material.
Differentials are part of mathematics that is considered very difficult and abstract compared with other mathematics subjects; these subjects is something new for high school students. It takes primary subjects like algebra, arithmetic, and geometry to be able to master these subjects. There are several factors that contribute to the poor results of learning mathematics students, among others: the ability of teachers in applying methods or learning strategies that are less precise, because during this time the process of learning used is to use conventional learning model lectures, questions and answers, tasks, and education is dominated by teachers and little involving students. Therefore, the students understand math without reasoning. Also, the interaction between students and teachers during the teaching-learning process is minimal. Thus an appropriate learning model is needed to teach differential concepts. For example, learning with cognitive conflict strategy \[3\].

Cognitive conflict is a situation where there is a mismatch between the cognitive structure (schemata) that a person possesses or possesses with new information he/she can get from outside, so the further information he accepts does not match the cognitive structure he already maintains \[4\]. According to, the cognitive conflict process involves three stages are: preliminary is done by presenting the cognitive conflict, conflict is the creation of disputes with the help of demonstration activities involving assimilation and accommodation process, and the resolution of discussion and concluding the review. The core activity steps on cognitive conflict strategies can be seen in figure 1.

![Figure 1. Didactic strategy modification.](image)

Studies and research on the effectiveness of cognitive conflict strategies are felt to be lacking with other methods \[5\]. Therefore, it is necessary to examine how the effectiveness of cognitive conflict strategies is compared with conventional learning. The purpose of this research is to know the efficacy of cognitive conflict strategy compared with the traditional education model. In this study, students of the experimental class were asked to observe and analyze the problems posed by the teacher regarding the differential material. While the control class students learn by teaching as do ordinary teachers. Furthermore, a differential knowledge test is given.

The results show that cognitive conflict strategies are more effective than ordinary models. This is because in cognitive conflict strategies, students reflect on how well they work in collaborative groups and how well they contribute, negotiate, listen, and welcome the ideas of other group members. Students also evaluate their projects, efforts, motivations, interests, and productivity levels. Students become critical friends by providing constructive feedback to each other, which helps them grow aware of their strengths and enhance their interactions with each other \[6\]. Therefore, cognitive conflict learning strategies can be an alternative for teachers to teach differential materials.

2. Experimental method
This research method is quasi-experiment where there are two groups of a sample of class. Then in both levels are given pretest and posttest, but the treatment is different that is given treatment with learning that uses cognitive conflict strategy and by applying ordinary education \[7\]. Data was collected in February-May 2017. The research instruments used were test and observation sheet. The population in this study is one of the State Senior High School in Cimahi City. The subject of the sample is high school students.
students of class XI. In class XI is taken two class samples from 8 classes that exist with Purposive Sampling technique that is sampling technique based on specific considerations. Variables in this study consist of two types, namely independent variables, and dependent variables. The independent variable in this research is learning with cognitive conflict strategy while the dependent variable is reasonable mathematical ability. The instruments used in this study consisted of tests (description of the description used to look at students' reasoning abilities), and non-tests (an attitude scale to measure students' mathematical dispositions). The technique used to analyze the data is by testing the prerequisite analysis, which is the normality test, homogeneity test and test the average difference of the pretest score on the students' initial ability in both the experimental and control classes. The techniques used to analyze posttest data in the hypothesis test are normality test, homogeneity test, normalized N-Gain test.

3. Results and discussion
In cognitive conflict strategies, students form groups of 6 - 8 students. Then, the teacher instructs the form of observation on the problems in the differential presented in the student worksheet. In groups students observe and discuss the issues that exist, then students are given direction how to find the concept of limits intuitively. That is understanding the idea of the left limit and right limit. In the project results, students have been able to understand the concept of left and right limits. In getting this concept of left and right limits students observe the table given by the teacher, then they begin to fill with numbers approaching the number 2. Some groups supplied with numbers far enough range such as numbers 0, 1, ..., 3, 4, 5 and 6. In this activity, the teacher does not direct the students how to find answers to the formulation of the problems they make. They learn from their previous results of knowledge and determine independently from the source of the book they are preparing. Then the teacher gives input in the form of filling the number of its range small as 1.9; 1.99; 1.999; .. 2.01; 2.001; 2.001. Moreover, continued by making a graph of the table that students have created. From the figures that have been made, students observe that there is one part that does not get the line, at this stage, there is cognitive conflict in the students.

However, in reality, there is one group that has not been able to find an answer to a problem the group has chosen. This is because students are not familiar with the given learning strategy. Thus, in cognitive conflict strategies teachers have an essential role as facilitators to assist students in learning. However, seven groups from 8 groups completed the task well and continued with the presentation. Teachers must evaluate and reward the group that successfully reports the best. In the control class, the teacher delivers the learning with the usual discussion and does the exercises independently. Based on the observation, students do look passive, not much activity, even sit still without doing the given problem. So teachers are very active in helping students in solving differential problems. At the tenth meeting, students are given postst about the ability of mathematical reasoning. The results of posttest of experimental class students and conventional models with clear strategies can be seen in table 1.

| Learning strategy | N  | Mean | Max value | Min Value | Standard Deviation |
|-------------------|----|------|-----------|-----------|--------------------|
| Cognitive Conflict| 35 | 43.66| 58        | 33        | 8.36               |
| Conventional      | 36 | 36.78| 52        | 24        | 8.69               |

Before performing the hypothesis test, it is necessary to do equivalence test on the student's first ability. The student's initial ability data is taken from the pretest result. Test normality using Kolmogorov-Smirnov. Normality test results can be seen in table 2.
Table 2. Test of predictive normality of mathematical reasoning.

| Class       | Kolmogorov-Smirnov | Decision     | Conclusion |
|-------------|---------------------|--------------|------------|
| **Statistic** | **Df** | **Sig.** | **H₀ is denied** | **abnormal** |
| Experiment  | 0.150   | 35      | 0.046       |             |
| Control     | 0.120   | 36      | 0.200       | normal      |

After the data is not normally distributed, proceed with test equality two pretest mean (two independent sample test) by using Mann-Whitney U. The Mann-Whitney test can be seen in table 3.

Table 3. Test of Mann-Whitney pre-test mathematical reasoning.

| Pre-test Reasoning | Mann-Whitney U | Wilcoxon W | Z  | Asymp.Sig.(2-tailed) |
|--------------------|----------------|------------|----|----------------------|
|                    | 576.500        | 1242.500   | -619| 0.536                |

From the table above for the pretest of reasoning ability mathematics is seen that the value of Asymp. Sig. (2-tailed) = 0.536 > 0.05 then H₀ is accepted, thereby concluded that there is no difference in students' mathematical reasoning abilities in the classroom with inductive-deductive learning with classes that receive ordinary learning. Furthermore, posttest analysis which includes the normality and homogeneity test is performed. The normality test is presented in table 4.

Table 4. Summary of normality test result.

| Class       | Kolmogorov-Smirnov | Decision     | Conclusion |
|-------------|---------------------|--------------|------------|
| **Statistic** | **Df** | **Sig.** | **H₀ is denied** | **abnormal** |
| Experiment  | 0.151   | 35      | 0.043       |             |
| control     | 0.144   | 36      | 0.058       | normal      |

From the normality test above shows, the experiment class data is not normally distributed while the normal class posted data normally distributed, then to test the hypothesis, then use the nonparametric statistical test Mann-Whitney U test. Mann-Whitney test can be seen in table 5.

Table 5. Test of Mann-Whitney post-test mathematical reasoning.

| Posttest Reasoning | Mann-Whitney U | Wilcoxon W | Z  | Asymp.Sig.(2-tailed) |
|--------------------|----------------|------------|----|----------------------|
|                    | 352.000        | 1018.000   | -3.203| 0.001                |

From table above obtained value. Sig (2-tailed) = 0.001 < 0.05 so H₀ is rejected, so it can be concluded that the achievement of students' mathematical reasoning abilities whose learning using cognitive conflict strategy is better than that of ordinary learning. To see the extent to which improvements in mathematical reasoning abilities between experimental and control classes are to be tested n- <gain>. The result of the n-gain test can be seen in table 6.
Table 6. t-test for the quality of mean.

| N-gain Penalaran          | Sig.(2-tailed) | Mean difference | Std. error difference |
|---------------------------|----------------|-----------------|-----------------------|
| Equal variances assumed   | 0.000          | 0.15549         | 0.04067               |
| Equal variances not assumed| 0.000          | 0.15549         | 0.04059               |

From the table above shows that the value of Sig. (2-tailed) = 0.000 < 0.05 then Ho is rejected. Thus it is concluded that the improvement of students' mathematical reasoning ability that gets cognitive conflict learning is better than the students who get regular learning.

Thus, it can be concluded that cognitive conflict strategies prove to be more effective than conventional learning. Hypothesis test results show that the learning model gives a different effect. Generally, applying cognitive conflict strategies is more effective than ordinary learning to gain better mathematical skills. This is consistent with the Chow study's average cognitive domain achievement group in which the cognitive conflict techniques used were found to be significantly higher than average for other groups. Based on these findings, it is certain that the Engineering project is effective in achieving targets in the cognitive domain [8]. Michael and Richard reported that inductive methods such as project-based learning are consistently found to be at least equal to, and generally more effective than traditional deductive methods to achieve learning outcomes [9].

4. Conclusion

Based on the results of research and discussion that has been described, it can be concluded that cognitive conflict strategy in mathematics learning of differential matter can improve students' mathematical reasoning ability. This can be seen from the hypothesis test on the difference test two average data of experimental class research results with the control class has a significant difference. Cognitive conflict strategy can be used as an alternative to the implementation of mathematics learning, but in the learning process teachers are expected to pay more attention to the basic skills of mastery of students' concepts to avoid misconception in learning mathematics. Moreover, more creative and innovative in choosing a model of learning for students. This study is just as our reference in the contribution of education, the rest may other researchers can choose other learning models or develop this model of learning better and better adjust the learning model used with the condition of the environment and conditions of students in the class to learn to run well [10].

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References

[1] S Fachry, A Rutgers and S F Assagaf 2014 Cognitive conflict supported by context to overcome misconception in the mathematics classroom
[2] F R Seke and J M Sumilat 2017 The Effectiveness of Project Based Learning in Trigonometry
[3] D Fraser and O D Fraser 2007 Using Cognitive Conflict to Promote a Structural Understanding of Grade 11 (Algebra Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of In the Faculty Education)
[4] N R Dewi and Y S Kusumah 2014 Developing Test of High Order Mathematical Thinking Ability in Integral Calculus Subject Int. J. Educ. Res. 2 (12) pp 101-108
[5] L Sayce 2010 The Way Out of Cognitive Conflict teachers in A planning toolkit for the teacher 5
[6] I Lyublinskaya 2006 Eurasia Journal of Mathematics, Science and Technology Education Sci. Technol. 2 (3) pp 125-137
[7] W Susilawati, D Suryadi and J A Dahlan 2017 The Improvement of Mathematical Spatial Visualization Ability of Student through Cognitive Conflict Iejme — Math. Educ 12 (2) pp 155-166

[8] A Jazuli 2013 Description of Mathematical Creative Thinking and Reasoning Ability of SMP Students in Islamic Culture-Based Learning Educare 6 pp 81-90

[9] R Johar and S Yusniarti 2018 The Analysis of Proportional Reasoning Problem in the Indonesian Mathematics Textbook For The Junior Journal on Mathematics Education 9 (1) pp 55-68

[10] M. Baser 2006 Fostering conceptual change by cognitive conflict based instruction on students’ understanding of heat and temperature concepts Eurasia J. Math. Sci. Technol. Educ. 2 (2) pp 96-114