# The Effect of Combination of Cooperative Learning Models and Prior Knowledge of Mathematics on Students' Achievement

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## Abstract

This experimental research of factorial 2 x 3 used 102 respondents as the samples of the research. The population of the research was 368 students of 10 classes in Junior High School 9 Kendari. This research was aimed to analyze: (i) the description of students' mathematics achievement, (ii) the effect of students' prior knowledge of mathematics on their mathematics achievement, (iii) the effect of factors of cooperative learning model interaction (Ai) and prior knowledge of mathematics (Bj) on students' mathematics achievement (Y), (iv) the effect of conditional factor Ai and Bj on mathematics achievement. The results of analysis concluded that: (1) empirically, the average score of mathematics achievement fluctuated on cell in supporting the proposed hypothesis, (2) students' prior knowledge of mathematics had significantly positive effects on mathematics achievement, (3) the average score of mathematics achievement for all cells formed by factor Ai and Bj had significant differences, (4) the effect of conditional Ai and Bj factors had significant differences on mathematics achievement in which combination of combination of NHT-Jigsaw types of cooperative learning model was higher than NHT type of cooperative learning.

**Keywords:** NHT-Jigsaw types cooperative learning, prior knowledge, mathematics achievement.

## 1. Introduction

Mathematics achievement problem still becomes the main topic of discussion of educational experts until nowadays either academicians such as lecturers, researchers, or students of undergraduate, postgraduate and doctoral program through seminar, symposium and scientific meeting. There are numerous factors that can affect mathematics achievement namely students' internal factors such as motivation, interest, prior knowledge, attitude, motivation to perform well, intelligence, anxiety and the other factors. Meanwhile, external factors are related to the factor of curriculum, teacher, teaching method, school discipline system, learning discipline, school management, school environment, family background, educational background of students' parents, students' parents incomes, government policy about the quality of education and learning generally has significant effect on mathematics achievement either through univariate or multivariate analysis in Junior High School level in Kendari, Southeast Sulawesi Province, Indonesia.

Mathematics is a basic science of other discipline and also as a means to train students to think critically and logically. In fact, mathematics is related to the ideas, structures and its relationships which are arranged based on logical order. Indeed, all of education components view mathematics as a system that contains inter-related elements (Hudoyo, 1979:48). According to Bourne in Ibrahim (2012:21), mathematics as social constructivism that emphasizes on *knowing how*, view students as active creatures in constructing science through interacting with their environment. On the contrary, absolutists defines *knowing how*, means that students are viewed as passive creatures that can be freely transferred information from action to the goals.

Mathematics is defined as a science acquired by thinking or reasoning. Mathematics is more emphasized on reasoning activities which are not from the results of experiment or observation. Mathematics is formed by the results of humans' reasoning that relate to the ideas, process and reasoning. Mathematics can be apprehended through humans' experiences in the world empirically. Then, the experiences are processed in reasoning to be analyzed in cognitive structure that yields mathematics concepts. To make someone is easy to comprehend mathematics concept, global mathematics language or notation is used. Mathematics concept is gained in the light of thinking process, thus logical is a foundation of mathematics (Ibrahim, 2012:12). Mathematics is linked to the ideas, structures and its relationships which are arranged based on logical order.

Mathematics learning based on KTSP aims to develop mathematics in which students are expected to show their understanding of mathematics concepts, to explain the relationship amongst concepts and apply them well-mannered, accurately and appropriately in solving problem. In fact, in the school, it is in contrast with the objective of KTSP where students still get difficulties to understand, explain and apply the mathematics concepts in solving problem so that students get low achievement in mathematics.

The successful learning of mathematics is closely linked to the role of teacher and students' ability. However, there are still some teachers that comprehend mathematics as arithmetic knowledge containing numbers that should be solved with a formula. The teachers' inclination is that only giving the formula or the solution without inculcating concept properly in advance. Besides, the teachers often give students assignment but they forget their accountability to follow, respond, or give reward to students. For instance, students' parents complain that their children have spent more time to do their homework, but the homework is not checked by the teacher at school. This fact shows that there are teachers who only teach. The formula has been exposed to students, they do exercises in the school and they go home bringing assignment. Therefore, teachers should change their attitude and upgrade their understanding because mathematics itself is always developed every moment. Teachers should think about the way to make students accept the inculcation of concept more communicatively with understandable language and draw attention to the mastery of previous material in order that they more easily understand the next material.

Students' prior knowledge of mathematics is one of factors that determine the students' success in learning mathematics. It is because mathematics lesson is hierarchy. It is impossible for students to learn a certain topic if they do not possess enough prerequisite knowledge. It prevails from elementary school level until university level. Maonde (2015:51) acknowledges that students' prior knowledge of mathematics is previous learning experience. Less than 7 years ago, students learned, however, they learned effectively only in five years when they started learning in the third grade of elementary school. It indicates that the students gained much knowledge during the time. It has been stored and adhered in the students' memory. Students who have long-term memory on mathematics lesson that had been learned in the past or past experience will answer all of the questions related to their prior knowledge correctly, otherwise, students who do not understand their prior knowledge in the past, they tend to answer the questions randomly. Dealing with mathematics lesson, for instance, adding operation in one century ago will not be different from the operation in the

next century. It means that the students, who comprehend, deepen and master the adding operation in 7 years or 5 years ago particularly for students who are currently in the second grade of Junior High School are too naive if they do not know knowledge that had been acquired in the past.

The demand of KTSP encourages teacher should employ an effective learning model. There are numerous learning models that have been applied by teachers in teaching and learning process. When there is a learning model that is assumed to be appropriate, hence teacher will incline to apply it regularly. However, despite the learning model applied in the learning is so effective, if it is implemented monotonously, it will be boring. It sometimes makes students are not interested in learning in the classroom particularly learning mathematics. Teacher should have attempted to expose new things in learning so that the students' boredom can be minimized and even lost. Therefore, it needs variation in determining an appropriate and interesting learning model in which students can learn in groups, ask their classmate regardless the teachers' presence in the classroom, and give their opinion in group. It can be undertaken through employing cooperative learning model.

Cooperative learning can be applied in order that students really acquire knowledge through learning experience with their friends either students who have high or low capability in understanding concept or learning material. One of characteristics in cooperative learning is the division of learning groups which are directed to achieve the success in mastering the taught concept. Besides, there is cooperation amongst students. Manning & Lucking (1992: 69) point out that working together atmosphere can arouse students' motivation to perform well in which it can be seen in learning activities through a desire to cooperate with the others even compete to get optimal achievement.

Ibrahim (2012: 140) recommends that promoting academic capability can be undergone through cooperative learning. Cooperative learning can give advantages either to low level or high level students who work together to accomplish academic assignments. High level students can be tutors of low ability level students; hence, in this case, they get special assistance from their tutors so that students' achievement in the classroom will be improved. Whereas, Trianto (2007: 41) points out that cooperative learning is derived from concept that students are more easily to find out and understand the complicated concept if they discuss amongst others with their friends. Students work together regularly in groups to assist each other to solve complex problems. According to Awofala (2012), "*The cooperative strategy also enhanced students' mastery of mathematics content at both the comprehension and*

*application levels than at the knowledge level of cognition."* It indicates that cooperative strategy increases students' mastery of mathematics better in the level of comprehension and application than in the level of cognitive knowledge.

Cooperative has some types of learning model from the simple model to the varied one. Some variations of cooperative learning employed by teacher aim to enable students to work together effectively to attain the shared goals of group. The models are Numbered Heads Together (NHT); Think-Pair-Share (TPS); Jigsaw; Teams-Games-Tournaments (TGT); Student Teams and Achievement Divisions (STAD); Team Assisted Individualization (TAI), etc. The structure of small cooperative groups that have the elements of learning groups by emphasizing on individual accountability in solving a problem for individual learning which are the most consistent and effective in promoting mathematics' achievement are NHT and Jigsaw.

Cooperative learning model which is little varied is Numbered Heads Together (NHT). The characteristic of NHT is that teacher only points out a student by mentioning one of numbers that represents his or her group to present the result of his or her group working. It is a tremendous effort to enhance individual accountable in group discussion while there is also individual interdependence in group, hence it can improve students' creativity in accomplishing group task.

Maheady (2006) pinpoints that "*NHT is a cooperative learning teaching strategy that incorporates a unique teacher questioning strategy that actively involves students while increasing their academic scores".* It means that NHT is a cooperative learning strategy that combines appealing strategy in teacher questioning strategy by involving students actively while improving their academic scores. According to Krismanto (2003), in NHT type of cooperative learning model, high ability level students will help low level students. This assistance underlies accountability and group's prestige. Low ability level students are expected to be more enthusiastic in apprehending problem and its answer because they feel that they are pointed out by teacher to answer it. Hence, all students will attempt to solve the problem that has been their accountability in the light of the pointing students' numbers by the teacher. Lie (2002) states that this NHT model gives chance to students to share ideas and consider the correct answers, encourages students to arouse their spirit of working and also it can be applied in all of lessons and levels of students.

Cooperative learning model that is more varied namely Jigsaw type of cooperative model. Jigsaw is developed and tried out by Elliot Aronson et al. in Texas University then

adopted by Slavin et.al. in John Hopkins University (Trianto, 2007: 56). The excellence of Jigsaw is requiring students' cooperation and accountability in learning. Students are divided into some groups and work together in the planning activities. In the planning activities, the expert and home groups will be formed. The expert groups have a purpose to gain information as many as possible related to certain topic assigned by their teacher to discuss. Then, the expert teams go back to their home groups to share the information to their friends. Jigsaw is designed to arouse students' accountability on their own learning and the others', hence through this model, students will be more easily to solve mathematics problems and it is expected to improve mathematics achievement.

Combining varied cooperative learning model is supposed to be effective to be implemented in mathematics learning to overcome boredom and to enhance students' mathematics achievement. The combination of cooperative learning model can create an active, effective and creative learning condition, and enjoyable learning that do not make students bored. The varied cooperative learning model can be implemented to ensure students really acquire knowledge from learning experience with their friends either high level students or low level students in comprehending concept or learning material. Nurani (2013) finds out that students' mathematics performance on Jigsaw-Make. Make-learning model is as good as students' mathematics performance on Jigsaw-NHT learning model, however, it is better than students' mathematics performance on conventional model.

NHT-Jigsaw type of cooperative learning model is a cooperative learning model that has similarities as follow: it can train academic skill, individual accountability, positive interdependence, the improvement of students' interaction, communication skill, discussion, working together, and also it can enhance students' achievement. The differences between NHT and Jigsaw are Jigsaw is underlined more on individual accountability in understanding material given by the teacher and then it enables to transfer the gained information to the other students. Meanwhile, in NHT model, the students who have high capability and accountability assist the other students who get difficulties in learning and solving problem assigned by the teacher. Therefore, this research was intended to combine cooperative learning models of NHT and Jigsaw types as alternative solution on mathematics' achievement in Junior High School.

## 2. Research Method

The type of this research was true-experimental research with research design of factorial 2 x 3 that used ANAVA-two lines with *Fixed Models.* This research was conducted in class VIII of Junior High School 9 in even semester of academic year 2014/2015 in Kendari, Southeast Sulawesi, Indonesia.

The sampling technique in this research was firstly used simple random sampling to select 4 homogeneous classes and to determine experimental and control classes. Eventually, class VIII-3 and class VIII-4 were experimental classes while VIII-8 and VIII-9 were control classes. After that, prior knowledge test was undertaken in each class arranged from the highest scores to the lowest score. Then, the scores were divided into groups in accordance with Kelley, Crocker & Algina in Surapranata namely by determining 27 % of high score groups and 27 % of low score groups (Supranata, 2005: 24). In determining the samples, it was based on the result of prior knowledge test after arranging the highest scores to the lowest score in experimental and control classes. The highest criteria was gained 27 % of the highest scores while the lowest criteria was gained 27 % of the lowest scores from the result of the prior knowledge test of mathematics, and the rest was students' prior knowledge of mathematics in moderate criteria. The number of samples was shown in Table 2.1.

**Table 2.1** Design of the Number of Samples in Experimental Research in Junior High School 9 Kendari, Southeast Sulawesi, Indonesia

| A | Prior Knowledge of Mathematics (Bj) | | | ∑ |
|---|---|---|---|---|
| | B1(High) | B2(Moderate) | B3(Low) | |
| A*1 | 17 | 17 | 17 | 51 |
| A2 | 17 | 17 | 17 | 51 |
| ∑ | 34 | 34 | 34 | 102 |

The variables in this research consisted of dependent variable namely students' mathematics achievement and independent variable namely combination of cooperative learning model as factor A and prior knowledge of mathematics as factor B. Factor A consisted of A*1; combination of NHT-Jigsaw types of cooperative learning model, A2; NHT type of cooperative learning model. Factor Bj (j=1,2,3): prior knowledge of mathematics that consisted of B1; high prior knowledge of mathematics, B2; moderate prior knowledge of mathematics and B3; low prior knowledge of mathematics. The research design of this research as follows:

| | | | |
|---|---|---|---|
| R | E | T | O1 |
| R | K | ● | O2 |

Notes: R is Random in experimental and control classes; E is treatment in experimental classes; K is treatment in control classes; T is True Experiment; ● is control class; O1 is students' mathematics achievement test in experimental classes; O2 is students' mathematics achievement test in control classes.

The technique of collecting data is the ways or steps in collecting data. The technique of collecting data used a test to measure students' prior knowledge of mathematics and mathematics achievement through the following steps: (i) arranging the research instruments ( lesson plan, worksheet, questions' grille of students' prior knowledge of mathematics and mathematics achievement, and scoring rubric with the investigated variables), (ii) inviting some experts to validate the research instruments, (iii) measuring the reliability of research instruments, (iv) revising the research instruments, (v) giving students prior knowledge of mathematics test in experimental an control classes, (vi) conducting research in the school, (vii) giving students mathematics' achievement test in experimental and control classes.

The simple linear regression analysis is the correlation between one independent variable (X) and one dependent variable (Y). The used data was interval scale. The following simple regression model was used to test the hypothesis 1: $Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$ ... (2.1)
Notes: Yi is the average score of students' mathematics achievement; $\beta_0$ is constanta; $\beta_1$ is regression coefficient; $X_i$ is respondent to-i, i=1, 2, ... n; $\varepsilon_i$ is random error rate, that is assumed to have identical and independent normal distribution with mean E($\varepsilon_i$) = 0, and variance constanta: Var($\varepsilon_i$) =$\sigma_1^2$ on model for i = 1,2,3… k.

Inferential analysis is an analysis used to test the research hypothesis. Inferential analysis is intended to test the hypothesis of the difference of treatment or effect between independent variable namely the combination of NHT-Jigsaw types of cooperative learning model (A*1), NHT type of cooperative learning model (A2), high prior knowledge of mathematics students (B1), moderate prior knowledge of mathematics students (B3) on dependent variable namely mathematics achievement (Y) by using non hierarchy-two factors variance analysis as follow: $Y_{ijk} = \mu + (AB)_{ij} + \varepsilon_{ijk}$ ... (2.2)

$Y_{ijk} = \mu + A_i + (AB)_{ij} + \varepsilon_{ijk}$ … (2.3); Where$Y_{ijk}$= observation to-*k* in cell (Ai,Bj) = (i=1,2) and j=1,2,3). μ = the parameter of average score of statistic Y, and $(AB)_{ij}$ = the parameter of the effect of interaction in cell (i,j), for i = 1,…,I; j = 1,… J; *k* = 1,…,$N_{ij}$; with the requirement: $\sum_i (AB)_{ij} = \sum_i (AB)_{ij} = 0, \forall i, j \quad \sum_i A_i = \sum_i (AB)_{ij} = \sum_i (AB)_{ij} = 0, \forall i, j$ And

$\varepsilon_{ijk}$ = random error rate with assumption of having identical and independent normal distribution with mean/expectation $E(\varepsilon_{ijk}) = 0$, and constant variance: $Var(\varepsilon_{ijk}) = \sigma_1^2$ ... Agung(2014). The equation of regression related to the equation (2.3) as follows:

$$Y_{ijk} = \alpha_0 + \alpha_1[A=1] + \alpha_2[A=1]*[B=1] + \alpha_3[A=1]*[B=2] + \alpha_4[A=2]*[B=1] + \alpha_5[A=2]*[B=2] + \varepsilon_{ijk} \quad ... (2.3a).$$

**Table 2.2** Parameter of Non Hierarchy Regression Coefficient Based on Model (2.3a)

| Cooperative Learning | Prior Knowledge of Matematics (Bj) | | | Range | |
|---|---|---|---|---|---|
| | High (B1) | Moderate (B2) | Low (B3) | (B1-B3) | (B2-B3) |
| NHT-Jigsaw (A*1) | $\alpha_0 + \alpha_1 + \alpha_2$ | $\alpha_0 + \alpha_1 + \alpha_3$ | $\alpha_0 + \alpha_1$ | $\boldsymbol{\alpha_2}$ | $\boldsymbol{\alpha_3}$ |
| NHT (A2) | $\alpha_0 + \alpha_4$ | $\alpha_0 + \alpha_5$ | $\alpha_0$ | $\boldsymbol{\alpha_4}$ | $\boldsymbol{\alpha_5}$ |
| Range(A*1-A2) | $\alpha_1+\alpha_2-\alpha_4$ | $\alpha_1+\alpha_3-\alpha_5$ | $\boldsymbol{\alpha_1}$ | | |

Notes:

$\boldsymbol{\alpha_1}$ is the difference of students' mathematics achievement taught by the combination of cooperative learning model (A*1) compared with students who were taught by NHT type of cooperative learning model (A2) if students had low prior knowledge of mathematics.

$\boldsymbol{\alpha_2}$ is the difference of students' mathematics achievement of high prior knowledge of mathematics compared with low prior knowledge of mathematics students if students were taught by the combination of cooperative learning model.

$\boldsymbol{\alpha_3}$ is the difference of students' mathematics achievement of moderate prior knowledge of mathematics compared with low prior knowledge of mathematics if students were taught by the combination of cooperative learning model.

$\boldsymbol{\alpha_4}$ is the difference of students' mathematics achievement ofhigh prior knowledge compared with low prior knowledge of mathematics if students weretaught by NHT type of cooperative learning model.

$\boldsymbol{\alpha_5}$ is the difference of students' mathematics achievement of moderate prior knowledge of mathematics compared with low prior knowledge of mathematics if students were taught by NHT type of cooperative learning model.

## 3. Results

### 3.1 *Descriptive Analysis of Students' Achievement Based on Factors Ai and Bj*

Descriptive analysis of mathematics achievement can be seen through the average score of standard deviation in each cell as shown in Table 3.1. The result of analysis empirically showed that the highest average score of students' achievement was factor $A_1B_1$ namely 73.7059 with standard deviation was 11.47568 while the lowest average score was factor $A_2B_3$ namely 31.2353 with standard deviation was 11.47568. It indicated students' achievement trough combination of NHT-Jigsaw types of cooperative learning model (A*1) was better than NHT type of cooperative learning model.

**Table 3.1** Descriptive Analysis of Mathematics Achievement Based on Combination of Cooperative Learning Model (Ai) and Prior Knowledge Levels (Bj)

| Ai | Bj | Mean | Standard Deviation | N |
|---|---|---|---|---|
| 1.00 | 1.00 | 73.7059 | 18.66402 | 17 |
| | 2.00 | 64.8235 | 18.35496 | 17 |
| | 3.00 | 53.7647 | 15.64660 | 17 |
| | Total | 64.0980 | 19.11780 | 51 |
| 2.00 | 1.00 | 53.9412 | 14.24110 | 17 |
| | 2.00 | 46.1765 | 18.06667 | 17 |
| | 3.00 | 31.2353 | 11.47568 | 17 |
| | Total | 43.7843 | 17.37966 | 51 |
| Total | 1.00 | 63.8235 | 19.17933 | 34 |
| | 2.00 | 55.5000 | 20.27725 | 34 |
| | 3.00 | 42.5000 | 17.69994 | 34 |
| | Total | 53.9412 | 20.84826 | 102 |

**3.2** *Inferential Analysis*

Inferential analysis is an analysis used to test the number of hypotheses of research. Inferential analysis was used to test some hypotheses of the effects of the average score of mathematics achievement in accordance with factor ($A_i$) of combination of cooperative learning model and factor ($B_j$) of students' prior knowledge.

Hypothesis 1.Students' prior knowledge of mathematics had significantly positive effect on mathematics achievement, $H_0$: $\beta_1 \leq 0$ versus $H_1$: $\beta_1 > 0$. The result of analysis in raw X Table 3.2 was gained the statistical t-Test = 5.119 and p-value/2 = $0.000 < \alpha = 0.05$, hence $H_0$ was rejected. It can be concluded that students' prior knowledge of mathematics had significantly positive effect on mathematics achievement with contribution 0.666 unit. It

indicated that each change of one unit of prior knowledge to improve mathematics achievement as much as 0.666 unit in the population.

**Table 3.2** The Result of Analysis of the Effect of Prior Knowledge of Mathematics Factor (X) on Mathematics Achievement (Y)

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 13.571 | 8.100 | | 1.676 | .097 |
| | X | .666 | .130 | .456 | 5.119 | .000 |

Hypothesis 2. The average score of mathematics achievement for all cells formed by combination of cooperative learning model factor ($A_i$) and levels of prior knowledge of mathematics had significant effect. $H_0 : (AB)_{ij} = 0$ versus $H_1$ : no $H_0$. The result of analysis on Table 3.2 in raw A*B was gained the statistical F-Test = 13.912 with p-value= 0.000<α=0.05, thus $H_0$ was rejected. It can be concluded that the average score of mathematics achievement for all cells formed by combination of cooperative learning model factor ($A_i$) and prior knowledge of mathematics factor had significant effect.

**Table 3.2** The Result of Analysis of the Effect of Interaction Factor Design A*B on Mathematics Achievement (Y)

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 18444.118[a] | 5 | 3688.824 | 13.912 | .000 |
| Intercept | 296784.353 | 1 | 296784.353 | 1119.258 | .000 |
| A*B | 18444.118 | 5 | 3688.824 | 13.912 | .000 |
| Error | 25455.529 | 96 | 265.162 | | |
| Total | 340684.000 | 102 | | | |
| Corrected Total | 43899.647 | 101 | | | |

Hypothesis 3.The average score of students' achievement between levels of prior knowledge of mathematics ($B_j$) for each level of combination of cooperative learning model factor ($A_i$) had significant effect. $H_0: (AB)_{ij} = 0$ versus $H_1$: No $H_0$. The result of analysis on Table 3.3 in raw A*B was gained the statistical F-Test = 7.469 with p-value= 0.000 <α=0.05 showed, thus $H_0$ was rejected. It can be concluded that the average score of mathematics achievement for low prior knowledge of mathematics students taught by the combination

NHT-Jigsaw types of cooperative learning model was better than students taught by NHT type had significantly different effect.

**Table 3.3** The Result of Analysis of the Effect of Interaction Factor Design A A*B on Mathematics Achievement (Y)

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Corrected Model | 18444.118[a] | 5 | 3688.824 | 13.912 | .000 |
| Intercept | 296784.353 | 1 | 296784.353 | 1119.258 | .000 |
| A | 10522.510 | 1 | 10522.510 | 39.683 | .000 |
| A*B | 7921.608 | 4 | 1980.402 | 7.469 | .000 |
| Error | 25455.529 | 96 | 265.162 | | |
| Total | 340684.000 | 102 | | | |
| Corrected Total | 43899.647 | 101 | | | |

Five conditional hypotheses as part of hypothesis-3 that rejected $H_0$ based on the result of analysis on Table 3.4 by drawing attention to the Table 2.2 as follows:

Hypothesis 3a.The average score of mathematics achievement for students who were taught by the combination of cooperative learning model was higher than students who were taught by NHT type if the low prior knowledge of mathematics had significantly different effect. $H_0$: $\alpha_1 \leq 0$ versus $H_1$: $\alpha_1 > 0$. The result of analysis on Table 3.4 in row [A=1,00] was gained the statistical value of t-Test = 4.034 with p-value/2=0.000<α=0.05, thus $H_0$ was rejected. It can be concluded that the average score of mathematics achievement for students who were taught by the combination of cooperative learning model was higher than students who were taught by NHT type if the low prior knowledge of mathematics had significantly different effect.

Hypothesis 3b.The average score of mathematics achievement of high prior knowledge of mathematics students was better than low prior knowledge of mathematics students if the students who were taught by NHT-Jigsaw types of cooperative learning model had significant effect. $H_0$: $\alpha_2 \leq 0$ versus $H_1$: $\alpha_2 > 0$. The result of analysis on Table 3.4 in raw [A=1,00]*[B=1,00] was gained the statistical value of t-Test = 3.570 with p-value/2 = 0.0005<α=0.05, thus $H_0$ was rejected. It can be concluded that the average score of mathematics achievement of high prior knowledge of mathematics students was better than low prior knowledge of mathematics students if the students who were taught by NHT-Jigsaw types of cooperative learning model had significantly different effect.

Hypothesis 3c.The average score of students' achievement of moderate prior knowledge of mathematics was better than low prior knowledge of mathematics students if the students who were taught by the combination of NHT-Jigsaw types of cooperative learning model had significantly different effect. $H_0$: $\alpha_3 \leq 0$ versus $H_1$: $\alpha_3 > 0$. The result of analysis on Table 3.4 in raw [A=1,00]*[B=2,00] was gained the statistical value of t-Test = 1.980 with p-value/2 = 0.051/2 =0.025<α=0.05, thus $H_0$ was rejected. It can be concluded that the average score of students' achievement of moderate prior knowledge of mathematics was better than low prior knowledge of mathematics students if the students who were taught by the combination of NHT-Jigsaw types of cooperative learning model had significantly different effect.

Hypothesis 3d.The average score of students' achievement of high prior knowledge of mathematics was better than low prior knowledge of mathematics students if the students who were taught by NHT type of cooperative learning model had significantly different effect. $H_0$ : $\alpha_4 \leq 0$ versus $H_1$ : $\alpha_4 > 0$. The result of analysis on Table 3.4 in raw [A=2,00]*[B=1,00] gained statistical value of t-Test = 4.065 with p-value/2 = 0.000/2 =0.000<α=0.05, hence $H_0$ was rejected. It can be concluded that the average score of students' achievement of high prior knowledge of mathematics was better than low prior knowledge of mathematics students who were taught by NHT type of cooperative learning model had significantly different effect.

Hypothesis 3e.The average score of students' achievement of moderate prior knowledge of mathematics was better than low prior knowledge of mathematics students if the students who were taught by NHT type of cooperative learning model had significantly different effect. $H_0$: $\alpha_5 \leq 0$ versus $H_1$ : $\alpha_5 > 0$. The result of analysis on Table 3.4 in raw [A=2,00]*[B=2,00] gained statistical value of t-Test = 2.675 with p-value/2 =0.009/2=0.004 < α=0.05, thus $H_0$ was rejected. It can be concluded that the average score of students' achievement of moderate prior knowledge of mathematics was better than low prior knowledge of mathematics students if the students who were taught by NHT type of cooperative learning model had significantly different effect.

**Table 3.4** The Result of Analysis of Conditional Interaction Factor Design A A*B on Mathematics Achievement (Y)

| Parameter | B | Std. Error | t | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Intercept | | 31.235 | 3.949 | 7.909 | **.000** | 23.396 | 39.075 |
| [A=1,00] | $\alpha_1$ | 22.529 | 5.585 | 4.034 | **.000** | 11.443 | 33.616 |
| [A=2,00] | | 0[a] | . | . | . | . | . |
| [A=1,00] * [B=1,00] | $\alpha_2$ | 19.941 | 5.585 | 3.570 | **.001** | 8.854 | 31.028 |
| [A=1,00] * [B=2,00] | $\alpha_3$ | 11.059 | 5.585 | 1.980 | **.051** | -.028 | 22.146 |
| [A=1,00] * [B=3,00] | | 0[a] | . | . | . | . | . |
| [A=2,00] * [B=1,00] | $\alpha_4$ | 22.706 | 5.585 | 4.065 | **.000** | 11.619 | 33.793 |
| [A=2,00] * [B=2,00] | $\alpha_5$ | 14.941 | 5.585 | 2.675 | **.009** | 3.854 | 26.028 |
| [A=2,00] * [B=3,00] | | 0[a] | . | . | . | . | . |

## 4. Discussion

### 4.1 *Description of mathematics' achievement Based on Factor Ai and* Bj

Empirically, the average score of students' achievement after being given treatment through implementing cooperative learning model (Ai) and prior knowledge of mathematics (Bj) had difference in each cell in supporting the proposed hypothesis. This discrepancy was caused by the diverse individual in receiving learning material when the teacher gave mathematics lesson in the classroom. The descriptive analysis was aimed to expose characteristic view of dependent variable namely mathematics achievement (Y) that could be seen through mean and standard deviation. Based on the descriptive analysis, the data of students' mathematics achievement in Table 4.1.a were gained from the average score of experimental classes was 64.098 and the average score of control classes was 43.7843. The average score represented the whole scores in each class. This findings show that the average score of students' mathematics achievement in experimental classes were better than control classes.

Prior knowledge of mathematics had significantly positive effect on mathematics achievement is the hypothesis 1 in this research. The significance of this hypothesis assumed that it is caused by prior knowledge of mathematics becomes a basic for students to learn the next material. It is because basically the simpler knowledge should be mastered well firstly so that students learn easily the more complicated knowledge.

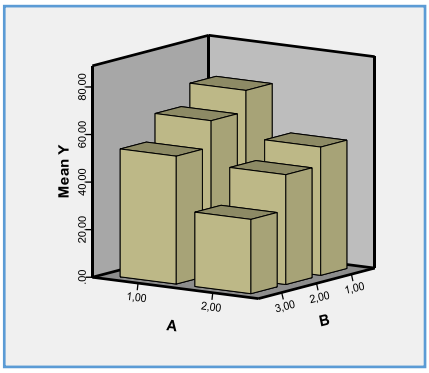


Figure. 4.1.a
Hystogram of Mean Score of Mathematics Achievement after the Experiment of Factor Ai and Bj

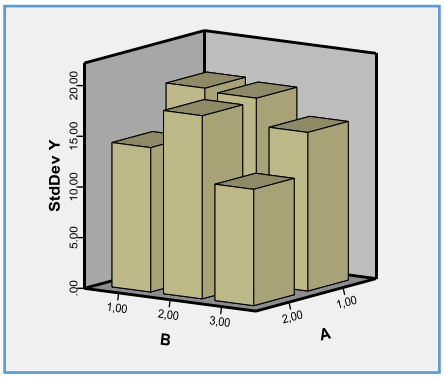


Figure. 4.1.b
Hystogram of Standard Deviation Dependent Variable Y after the Experiment of Factor Ai and Bj.

**4.2** *The Effect of Prior Knowledge of Mathematics (X) on Mathematics' Achievement (Y)*

According to Maonde ((2010:55-68) & (2011)), prior knowledge of mathematics is students' ability to remember learning material of mathematics that had been learned in the past and make it as a basis to facilitate in applying and correlating it with the next lesson. In learning new material, it is needed the use of material that has been mastered by students previously namely basic concepts of mathematics such as concept and operation (+), (-), (×), (:), ($\sqrt{}$), ($2^x$), fraction, percent, algebra and its application. Students who have high prior knowledge of mathematics are students who have strong mastery of mathematics basic concepts, thus meaningful learning in answering the questions can be created.

It is supported by the result of research conducted by Setyowati (2013) found that covariate of students' prior knowledge had significantly positive effect on mathematics achievement. In line with Ausuble theory that the knowledge that has been acquired by students will profoundly determine the successful learning process. Moreover, according to Gestalt theory, learning is a process of developing *insight*. *Insight* is an understanding of the correlation amongst parts in problem situation. The characteristic of insight that becomes the main point of learning is insight is influenced or depending on the relevant previous experience and the one's ability of insight depends on his or her basic competence.

**4.3** *The Effects of Combination of Cooperative Learning Model Interaction Factor (Ai) and Students' Prior Knowledge of Mathematics Levels on Students' Achievement (Y*)

Interaction means that the effect of independent variable on dependent variable that depends on the level of the other independent variables. The interaction of two factors namely

the combination of cooperative learning model and prior knowledge of mathematics influence each other on mathematics achievement. Obviously, the combination of cooperative learning model factor and prior knowledge of mathematics factor were depending each other in effecting mathematics achievement.

Cooperative learning model interaction factor and prior knowledge of mathematics through design A*B and A A*B. Based on the statistical F-Test, from the two proposed hypotheses gained H0 was rejected, hence the average score of mathematics achievement for all of cells formed by the combination of cooperative learning model (Ai) and prior knowledge of mathematics (B1) had significant effect.

The significant interaction on hypothesis 2 and 3 towards mathematics achievement was assumed in the light of combination of cooperative learning model and prior knowledge of mathematics that depending each other in influencing mathematics achievement. Besides, it is because during the discussion in cooperative learning process, it profoundly enables students to get a lot of information from each member of groups. The more complex the prior knowledge of mathematics, the worthier the students' discussion is. The supporting prior knowledge of mathematics enables students' discussion run well because this knowledge can be used by each member of groups to study the subtopic that becomes groups' accountability; hence the mastery of learning material will be easier. It is supported by a research conducted by Setyowati (2013) found that interaction factor through design A*B and A A*B was significant. Similarly, Asriadi & Sappaile (2015:30-40) found that interaction through design A*B was significant as well. Nevertheless, Maonde, Lambertus & Meni (2015:59-70) showed that interaction factor through design A*B and A A*B had no significant effect. It indicates that the average score gained by students in each cell relatively had no difference in supporting the proposed hypothesis.

One of theories that support this research finding is Kerlinger theory (2004) which indicates that interaction is the cooperation of two independent variables in influencing dependent variable that depends on level of the other independent variables. In other words, interaction happens when an independent variable has different effects on dependent variables on various levels of the others independent variables. Besides, Kerlinger states that interaction also can happen in spite of the independent variables can bring consequences separately and individually. Otherwise, interaction cannot happen if more than one independent variable brings separate consequences.

**4.4** *The Effect of Factors of Conditional Interaction of Combination of Cooperative Learning Model(Ai) and Prior Knowledge of Mathematics Levels (B) on Students' Achievement (Y)*

Conditional interaction of combination of cooperative learning model factor and prior knowledge of mathematics through design A A*B with the requirement was that cooperative learning model consisted of 5 hypotheses. 2 of 5 hypotheses were (a) significantly, the average score of mathematics' achievement of high prior knowledge students was better than low prior knowledge students taught by the combination of NHT-Jigsaw types of cooperative learning model, (b) significantly, the average score of students' mathematics achievement of moderate prior knowledge students was better than low prior knowledge students taught by NHT type of cooperative learning model.

In line with the result of descriptive analysis that the highest average score of students' mathematics gained from students taught by the combination of NHT-Jigsaw types of cooperative learning model particularly for high prior knowledge students was 73.7059. Meanwhile, the lowest average score of mathematics gained from low prior knowledge was 31.2353. It showed that the effect of NHT-Jigsaw types of cooperative learning model on mathematics achievement depended on students' prior knowledge of mathematics category. In other words, the difference of students' achievement given mathematics lesson that was taught by combination of NHT and Jigsaw types of cooperative learning model was better than students taught by NHT type of cooperative learning model in general or it was based on students' prior knowledge of mathematics category.

The result of this research is confirmed by Sholikah (2012) who found that combination of Reciprocal Teaching and Numbered Heads Together (NHT) can enhance students' achievement. Moreover, Nurani (2013) acknowledged that students' mathematics achievement on Jigsaw-*Make a Make* is as good as students' mathematics achievement taught by NHT-Jigsaw types of cooperative learning model, however, it is better that students' mathematics achievement on conventional model.

In each class either in experimental and control classes, the highest average score of mathematics achievement gained from high prior knowledge of mathematics students. Otherwise, the lowest average score of mathematics achievement gained from low prior knowledge of mathematics students. Moreover, the moderate average score of mathematics achievement gained from moderate prior knowledge of mathematics students.

It was probably caused by the high prior knowledge of mathematics students mastered the material more quickly in the light of having prior knowledge such as concept and basic

mathematics operation, and its application, hence students could comprehend the material well either computationally or conceptually. Meanwhile, the low prior knowledge of students got difficulties to understand the new material because they could not link between new concept and old concept. Therefore, the high prior knowledge of mathematics was better than the low prior knowledge of mathematics students on the material of circleand tangent of circle.

The supporting is Kerlinger theory (2004) who stated that the interaction effect is the effect caused by the existence of interaction between one independent variable and the other independent variables on an analysis model. Thus, the interaction effect is an effect caused by an independent variable with considering the existence of another independent variable.

## 5. Conclusion

Prior knowledge of mathematics had significantly positive effect on students' mathematics achievement with contribution as much as 0.666 unit. It indicated that each change of one unit of students' prior knowledge could improve mathematics achievement was 0.666 unit with contribution was 45.6 % and the rest was 54.4 % determined by another factor in the population. The average score of mathematics achievement for all cells formed by cooperative learning model factor (Ai) and levels of prior knowledge of mathematics (Bj) had significant effect. The average score of mathematics achievement between levels of prior knowledge of mathematics factor for each level of combination of cooperative learning model factor had significant effect and the average score of students' mathematics achievement of high prior knowledge of mathematics was better than low prior knowledge of mathematics taught by the combination of NHT-Jigsaw types of cooperative learning model had significant effect.

## 6. Suggestion

Combination of NHT-Jigsaw types of cooperative learning model can be used as an alternative to increase students' mathematics achievement particularly in learning material of circle and tangent of circle. In mathematics learning using combination of NHT-Jigsaw types of cooperative learning model, teachers should prepare the learning instruments and classrooms well in order that learning process run effectively and efficiently. Besides, teachers should pay attention and understand students' characteristic, for instance, students' prior knowledge of mathematics levels are high, moderate and low. By seeing the difference

of students' prior knowledge of mathematics, teachers are expected to can give positive reinforcement so that students are motivated to develop their potential to learn and to work together well in learning mathematics. The next researchers are hoped to be able to develop further research for the other variables or learning models, thus it can add an insight and a better quality of education particularly mathematics education.

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