

The effect of numbered heads together (NHT) cooperative learning model on the cognitive achievement of students with different academic ability

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Abstract. Learning models and academic ability may affect students' achievement in science. This study, thus aimed to investigate the effect of *numbered heads together* (NHT) cooperative learning model on elementary students' cognitive achievement in natural science. This study employed a quasi-experimental design with *pretest-posttest non-equivalent control group* with 2 x 2 factorial. There were two learning models compared NHT and the conventional, and two academic ability high and low. The results of ana Cova test confirmed the difference in the students' cognitive achievement based on learning models and general academic ability. However, the interaction between learning models and academic ability did not affect the students' cognitive achievement. In conclusion, teachers are strongly recommended to be more creative in designing learning using other types of cooperative learning models. Also, schools are required to create a better learning environment which is more cooperative to avoid unfair competition among students in the classroom and as a result improve the students' academic ability. Further research needs to be conducted to explore the contribution of other aspects in cooperative learning toward cognitive achievement of students with different academic ability.

1. Introduction

One of the aims of science education to elementary students is to prepare them before encountering real environment. Science learning has helped develop students science literacy as they also take a part in the society who are faced with various problems related to science such as pollution, flood, global warming, diseases, and recycling. In achieving the goal, the students are necessarily taught how to develop a higher order thinking which covers the analysis, evaluation, and creations domains. As a result, the students are more aware of and able to deal with the problems. They can be engaged in a learning activity which improves their scientific performance as well as their ability to define the issues. Cooperative learning is an especially effective method to use with any problem-solving task because it encourages people to express divergent points of view.

In Indonesia learning framework, cognitive achievement still becomes the main focus for teachers and schools, as well as students' main target. A cognitive achievement is the representation of students' intelligence quotient. Several education policies were done to improve students' learning outcome to obtain the standard. Therefore, the learning plan, practice, and evaluation must involve cognitive aspects holistically. In fact, the learning pattern in Ambon-Indonesia, especially in science subject tends to focus on the low cognitive. It is because many teachers think that elementary school students cannot perform high order thinking skill. Thus the learning pattern is constructed as simple as possible, as long as students know. The evaluation instrument is in the form of multiple choice or



essay test which is dominated by C1-C3 cognitive level. This condition reflects that the orientation of the learning pattern in classroom focuses on the low level of cognitive achievement.

The researchers found the teachers' difficulties when they are involved in a social activity, particularly for the teachers in KKG (*Teacher Work Group*) IV and VI of Sirimau in July-September 2016. The lack of understanding and best practices of the implementation of various student-centered learning models makes the teachers cannot design a relevant activity. The reality reveals that it is necessary to provide learning models and materials which are suitable for the development of elementary school students' characteristics. Based on Piaget's development level, elementary school students are at the level of concrete operational which needs a social interaction including with teachers and peers to understand the concept learned, especially in science learning. The cooperative model is a constructivism and collaborative which encourages students to interact with other people [1]. Cooperative helps students to develop their understanding when doing social interaction in a group and presentation, one of this model is Numbered Heads Together (NHT), which considered relevant for elementary school students. NHT emphasizes members' responsibility to do their tasks based on their number. Students are to show their capability and use any strategies to reveal their responsibility. Students are also trained to understand every task comprehensively. Hence, the students' responsibility is not merely on the individual project, but also as a member of a particular group. This process encourages students' ability to solve problems and students comprehensiveness. Thus, NHT can improve students' cognitive achievement. Besides, as a part of cooperative learning models, NHT contributes students' social skill improvement, when they interact with teachers and peers during the learning [2].

The class is a diversity miniature of students. One of the diversity aspects is unavoidably academic ability. In a cooperative learning atmosphere, heterogeneity is a valuable. Besides promoting students to the real world, heterogeneity also provides students to build a good relation or social competition [3]. Students' different academic ability can be accommodated within NHT learning pattern. Learning process and students' motivation might improve if teachers can conduct an appropriate learning that is suitable with students' various need and ability [4]. Compared to low academic ability students, those with high academic ability tend to pursue more challenging objectives, have more self-motivation, more idealism to be a success, and less hesitation to their academic performances [5].

Many previous studies reveal the effect of NHT [6-14]. A beneficial process in cooperative learning especially in the cognitive achievement is the social interaction. Vygotsky's (1978) theories emphasize the contribution of social interaction to cognitive development which may impact to academic achievement. Educators construct an education through individual interaction within society and learning is considered as the result of the internalization of social interaction. An interaction fosters an individual to cope with the diversity of life styles, experiences, attitudes, ideas, and opinions [15]. Also, Slavin [16] asserts that cognitive perspective focuses on the interaction among students in groups. The interaction contributes to the improvement of the learning process as well as encourages students' academic. It is in line with Pham's [17] statement that cooperative learning model enables high and low ability students to help and motivate each other to improve their academic performances.

The purpose of this study was to examine the comparison of students' achievement based on learning model and different academic ability. There are three hypotheses of the study: 1) There is a different cognitive achievement of students who experience NHT cooperative learning and students who experience conventional models. 2) There is a different cognitive achievement of high academic ability students and low academic ability students. 3) There is a different cognitive achievement in learning model interaction and academic ability. This information are important in encouraging the constructivism learning which is mostly omitted during the learning activity.

2. Method

This study was a comparative study, which was conducted in the form of quasi-experimental with pretest-posttest non-equivalent control group design. This study used 2 x 2 factorial pattern, including two variables with two levels. The first variable is the learning models, involving NHT cooperative

learning and conventional learning model. The second variable is students' academic ability which is divided into high and low academic ability.

Four core schools in Sirimau District area were selected as the population of the study. The researchers chose the schools randomly. The samples of the study were 100 fifth graders who enrolled in the academic year 2016-2017. Their academic ability comprised two elements including high and low performance based on the students' academic record scores in the previous semester and an interview. The students who attained scores in the interval top 33,3% were considered as high academic ability students, while the students who obtained scores in the interval bottom 33,3% were considered as low academic ability students.

The cognitive achievement test which was constructed by the researcher referred to the domain from level C1 to C6. The instrument has been going through construct validation, and empirical try out in the form of essay test. The cognitive achievement test was administered twice, in pretest and posttest. The data of the study were analyzed descriptively and statistically using ana Cova in SPSS 17.00 computer program for windows to test the hypotheses of the research.

3. Results and Discussion

The research results describe the students' cognitive achievement and the hypotheses. The data description of the cognitive achievement is in the form of the mean score of pretest and posttest based on the learning models and the students' academic ability. Figure 1 presents these results as follows.

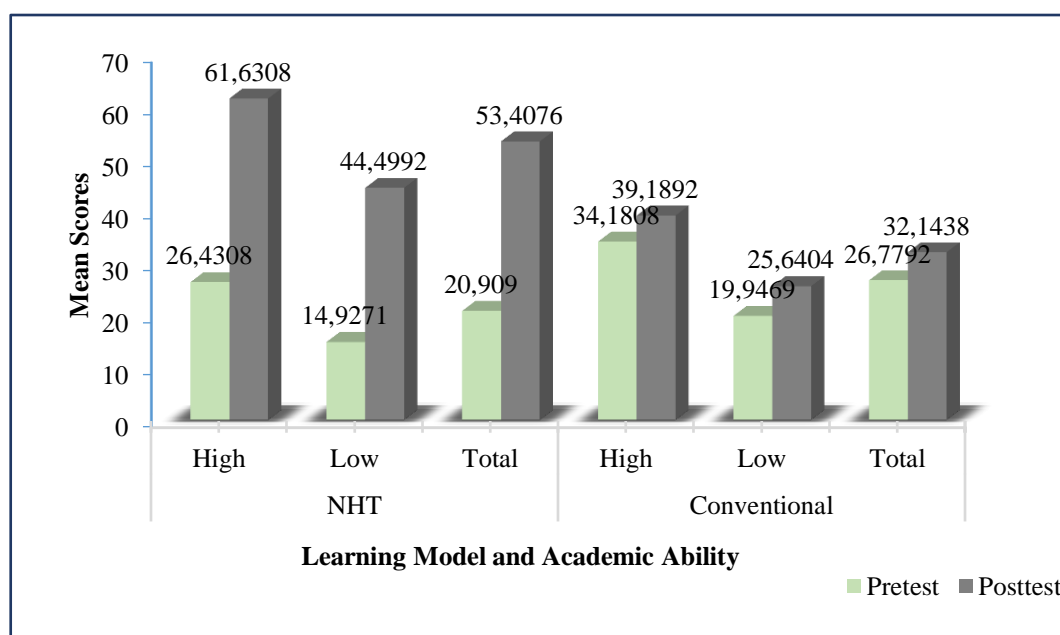


Figure 1. The comparison graphic of the students' cognitive achievement based on learning models and academic ability

Figure 1 shows that: 1) in low academic groups, the mean pretest score of the students who experienced conventional learning is 33.63% higher than the mean pretest score of the students who experienced NHT. 2) In high academic groups, the mean pretest score of the students who experienced conventional learning is 29.32% higher than the mean pretest score of the students who experienced NHT. 3) In low academic ability groups, the mean posttest score of the students who experienced NHT is 73.55% higher than the mean pretest score of the students who experienced conventional. 4) In high academic groups, the mean posttest score of the students who experienced NHT is 57.26% higher than the mean pretest score of the students who experienced conventional. Table 1 depicts the results of the ana Cova test.

Table 1. The ana Cova test result of the effect of learning model and academic ability to cognitive achievement

Source	Type III Sum Of Squares	Df	Mean Square	F	Sig.
corrected model	17844,845 ^a	4	4461,211	74,662	,000
intercept	10878,018	1	10878,018	182,052	,000
pre test	587,390	1	587,390	9,830	,002
learning model	10896,453	1	10896,453	182,361	,000
academic	1782,420	1	1782,420	29,830	,000
model * academic	123,656	1	123,656	2,069	,154
error	5676,461	95	59,752		
Total	206497,357	100			
corrected total	23521,306	99			

Table 1 illustrates some information as follows.

3.1 The difference of the students' cognitive achievement based on learning model

The F observed of the learning model is 182.361, p-value $0.000 < \alpha$ (0.05). Hence, H₀ stating there is no cognitive achievement difference between students who experienced NHT and conventional learning model can be rejected. It means, there is an effect of learning model to students' cognitive achievement. Therefore, it is not necessary to conduct Least Significant Difference (LSD) test for the present study only consisted of two groups. Table 2 provides information on students' diverse learning achievement in every model.

Table 2. The mean of the cognitive achievement of each learning model group

No.	Learning Model	Pretest	Posttest	Different
1	Conventional	26.779	32.144	5.365
2	NHT	20.909	53.408	32.499

Based on Table 2, it can be seen that the group which was treated using NHT cooperative learning has a higher mean than the group which was treated using conventional. The cognitive achievement of the students who experienced conventional improves 20.03%, while the students who experienced NHT improve 155.43%. It means the learning outcomes of the students who experienced NHT is 72.45% higher than those who experienced conventional model.

The cognitive achievement mean score of the students who experienced NHT improved higher than mean score of the students who experienced conventional model. Cooperative learning model encourages the students to cooperate in a group so well that creates meaningful learning process and enhances the students' cognitive achievement. This process might help students to develop academic performances [18].

There are several supporting aspects in NHT cooperative learning activity. They are openness, critics/suggestions, assistance, dynamic, and tolerance [19]. In a multi-dimension cooperative class, a group dynamics is an inevitable condition. Willingness to obtain group objectives needs all of the above-mentioned aspects. Openness means that students and teachers need to be sincere to accept suggestions during the learning activity. Teachers may know some things that students do not know, vice versa. Therefore, both of them can complement one another during the learning activity. In cooperative class, each person can deliver opinion or critics, to explain some misconceptions of some things. Critics are addressed to construct knowledge appropriately. They encourage people to develop a mindset that every person is in the right track. Some assist will be provided to encourage the similarity point of view. A good thing in cooperative learning class is dynamic. When an individual admits his weakness, he has to be ready to change. The dynamic aspect appears in cooperative learning. Another aspect is tolerance, in which students need to tolerate persistent differences.

Based on the analysis of the participants' responses and interview results, there were some differences found in their answers. To answer question number 2c "Explain the reasons of why smoking is not good for health?". The answers is presented in figure 2 and 3 below.

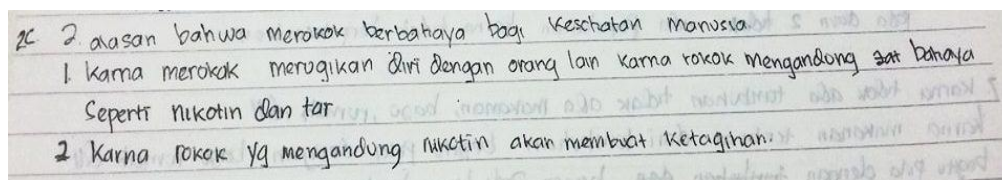


Figure 2. Student answers for the problem number 2c

Students who learned using NHT model provided responses as follows. Smoking is not good for health because; 1) a cigarette contains chemicals which are harmful such as nicotine and tar. 2) nicotine inside the cigarette is addictive. The students explained the reasons of why smoking can be disadvantageous; because it contains chemicals such as nicotine and tar, which can cause addiction. The students can express their opinions and associate them with the impacts of smoking based on their own life experiences.

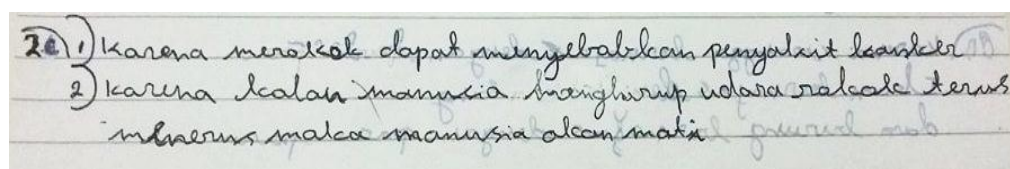


Figure 3. Student answers for the problem number 2c

Students who were taught with conventional models provided reasons related to the effect of smoking on human's health that is cause diseases. They answered: 1) smoking habit can result in cancer, 2) humans risk their lives by inhaling the smoke produced from cigarettes.

The students who experienced learning with NHT were used to building a concept to think deeper or to think at the higher order level in facing problems. They are trained to argue and explain rationales of a problem. First, they will solve a problem individually and then discuss it in a group while communicating, sharing experiences with other students and resolve problems together. On the other hand, the students who were accustomed to learning with conventional models were exposed to memorization of a concept from textbooks. They were likely to have little interaction with other students because they could not work cooperatively.

Cognitive achievement provides information related to achievement or index which is valuable and can be used to examine the cooperative activity in a group [20]. The students who were involved showed better cognitive achievement than the students who learned individually learning as the consequence of transfer knowledge activity from group to individual. In cooperative learning, the member shared information partially, then fused, corrected, and revised so that their knowledge and understanding improved. Also, students comprehend the collective knowledge of the group. The NHT cooperative learning group test score should have smaller standard deviation than the conventional learning group test score.

NHT emphasized on the students' responsibility. This learning model fostered the students to learn the material given as well as to examine their comprehension. NHT provided times for students to think and find appropriate solutions. Interaction among students also helped the students to strengthen their understanding and long-term memories to the solutions. NHT stressed the students' participation in learning especially in answering each question so that the students had to be ready anytime. The students shared knowledge until they were able to find the appropriate solution. This model was able

to provide opportunities for the students to think deeper, adjust every solution given by the group member, provide the best solution, and make a responsible decision.

3.2 The effect of academic ability to cognitive achievement

The F observed of the academic ability is 29.830, p-value $0.000 < \alpha$ (0.05). Hence, H_0 stating there is no cognitive achievement difference between high and low academic ability students cannot be accepted. It means, there is an effect of the academic ability to students' cognitive achievement. Therefore, it is not necessary to conduct LSD test for the present study only consisted of two groups. Table 3 presents differences in students' performance from each academic group.

Table 3. The mean of the cognitive achievement of each academic ability group

No	Academic Ability	Pretest	Posttest	Different
1	Low	17.537	34.693	17.155
2	high	30.151	50.859	20.708

Table 3 indicates that students with high academic performance had higher mean scores compared to those coming from low academic performance. The cognitive achievement of the low academic ability students improves 97.82%, while the cognitive achievement of the high academic ability students improves 160.23%. It means the cognitive achievement of the high academic ability students is 33.03% higher than the low academic ability.

The ana Cova test result shows that there is a cognitive achievement difference between high academic ability students and low academic ability students. Learning outcomes of students with low academic ability have significantly improved from pretest to posttest. The interaction between high academic ability students and low academic ability students in the group influenced their learning process. The process contributes to the individual behavior changes which cause achievement improvement [21]. The low academic ability students tended to face some difficulties and thus they needed help or supervision during peer interaction, especially with high academic ability students. During the interaction activity, the students clarified and shared ideas between group members. The interaction contributes to the achievement improvement. Interaction may assist students in finding solutions to problems, as well as motivate them to resolve the problems by themselves.

Toward question 3a "Fish use their gills to breathe, whales and dolphins breathe through their lungs, and insects use trachea to take in oxygen. What can you infer from this statement?. The students provided various answers are presented in figure 4 and 5 below.

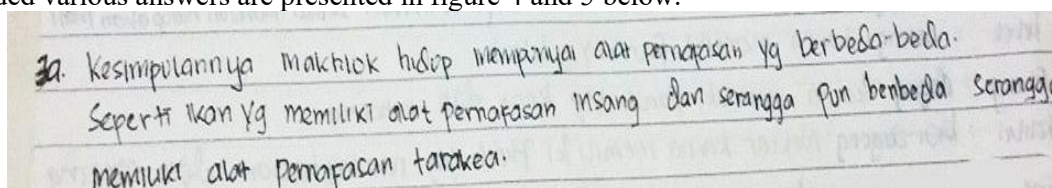


Figure 4. Student answers for problem number 3a

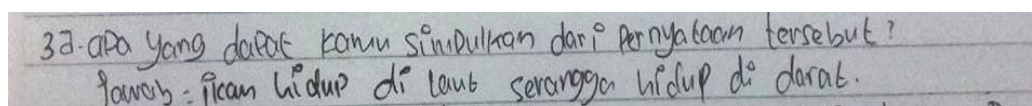


Figure 5. Student Answers for Problem Number 3a

Students with higher academic ability answered: it can be concluded that living creatures use different organs to breathe. For example, fish have gills and insects have trachea. Students with low academic ability answered: fish live in the sea, insects live on the land. These results indicated that the students with higher academic ability can carefully draw a conclusion based on the statement. The students were well informed that fish, whales, dolphins, and insects represent the animal groups while

gills, lungs, and trachea are organs of respiratory system. These students had an ability to examine facts and use their logic to draw a conclusion. Meanwhile, the low ability students associated their thoughts with animals' habitats. They tended to make a wrong inference since they were not able to synchronize their logic. This probably happens because they forgot or even had no idea about animals' respiratory system organs such as gills, lungs, and trachea.

Different academic ability emphasizes different experiences of students. Students construct new experiences during the learning process. There is a study that compares students' experiences in cooperative learning and In a big group conducted by Mulryan [22]. In her study, Mulryan observed fifth and sixth-grade students since they were involved in small and big groups in mathematics subject. Holistically, she found that the students tended to participate in the small groups rather than in big groups. However, their performance to the tasks given depended on their academic level. The high academic ability students were significantly involved in the small groups than in big groups, while the low academic ability students in the small groups was not significantly different than their involvement in big groups. This fact shows not only the importance of comparing students' experiences based on instructional models but also considering the grouping and managing students who can influence various students.

High academic ability students tend to show prominent performance compared to low academic ability students. They tend to be superior in group discussion activity or presentation, due to their self-confidence. After conducting an ANOVA test analysis, it is shown that early academic ability might influence students' cognitive achievement. The students with high early ability tend to have a high academic ability. Hence, the high academic ability students can improve their achievement by attaining information during learning process and keeping the information as new knowledge.

Teachers are expected to supervise and guide students in a group activity. It enables low academic ability students to be involved in doing group tasks. The result of this study shows that the improvement of the achievement also occurred on low academic ability students. It is necessary to highlight that low academic ability students were doing good performances in constructing their knowledge. Students are more motivated when they are allowed to interact with each other in a group.

3.3. *The difference of cognitive achievement based on the interaction between learning model and academic ability*

The F observed of the interaction between learning model, and academic ability is 2.069, p -value $0.154 > \alpha$ (0.05). Hence, H_0 stating there is no cognitive achievement difference in the interaction between achievement and different academic ability is accepted. Hence, the alternative hypothesis stating there is no different cognitive achievement in the interaction between learning model and academic ability can be rejected. It means, there is no effect on the interaction between learning model and academic ability towards students' cognitive achievement. The ANOVA test result shows that there is no effect on the interaction between learning model and academic ability towards students' cognitive achievement. Therefore, it is necessary to conduct LSD test to examine the interaction position. Table 4 shows the results of the LSD test.

Table 4. The mean of the cognitive achievement on the interaction group

No.	Interaction	Pretest	Posttest	Different	Mean	Notation
1	conventional - low	19,947	25,640	5,693	26,907	a
2	conventional - high	34,181	39,189	5,008	35,830	b
3	NHT - low	14,927	44,499	29,572	47,397	c
4	NHT - high	26,431	61,631	35,200	60,790	d

The results provide the following information: 1) The students' cognitive achievement in conventional-low academic ability is significantly the lowest than the other interaction. 2) The students' cognitive achievement in NHT-high academic ability is significantly the highest among the other three interaction. The cognitive achievement in the conventional-high academic ability group improves 14.65%, in the conventional-low academic ability improves 28.54%,

in the NHT-high academic ability improves 133.18%, and in the NHT-low academic ability is 198.11%.

The ana Cova test result shows that there is no effect on the interaction between learning model and academic ability towards students' cognitive achievement achievement. The interaction between learning strategy and academic ability does not influence students' satisfaction in learning [23]. For students who have a moderate academic ability, cooperative or conventional learning makes their process easier. While for low academic ability students, either cooperative or in conventional model class might still make them difficult to learn.

The cognitive achievement between NHT-high academic ability and NHT-low academic ability is not significantly different, likewise conventional-high and low academic ability. As a consequence, there are no cognitive achievement differences in the interaction between learning model and academic ability. Thus, all interaction causes the same effect. The NHT provides the same opportunity to think and memorizes each solution [24]. Besides, NHT also facilitates the students to have self-preparation in justifying the group performances, so that the low academic ability students tried their best. In the conventional learning, the real competition is unavoidable. Both the high and low tried to get the maximum result. While in fact, the improvement of the low academic ability students was not significant.

4. Conclusions

The findings provide the following conclusions: 1) NHT is 72.45% more potential to improve cognitive achievement rather than conventional learning model. 2) The high academic ability students' cognitive achievement is 30.03% different compared to the low academic ability students. 3) There is no effect on the interaction between learning model and academic ability. However, based on the LSD test, it is obtained that the mean of the cognitive achievement in the interaction between conventional-low academic ability is significantly different from the cognitive achievement in the interaction between conventional-high academic ability, NHT-low academic ability, and NHT-high academic ability. Moreover, the other interaction groups show the significant mean of the cognitive achievement.

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