Group investigation with scientific approach in mathematics learning

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Abstract. The aim of this research is to find out the effect of learning model toward mathematics achievement. This research is quasi-experimental research. The population of research is all VII grade students of Karanganyar regency in the academic year of 2016/2017. The sample of this research was taken using stratified cluster random sampling technique. Data collection was done based on mathematics achievement test. The data analysis technique used one-way ANOVA following the normality test with liliefors method and homogeneity test with Bartlett method. The results of this research is the mathematics learning using Group Investigation learning model with scientific approach produces the better mathematics learning achievement than learning with conventional model on material of quadrilateral. Group Investigation learning model with scientific approach can be used by the teachers in mathematics learning, especially in the material of quadrilateral, which is can improve the mathematics achievement.

1. Introduction
Mathematics has been widely used for the development of science. Mathematics is one of the subjects given at every level of education. The standar aims of school mathematics are the generally agrees basic and functional goals to develop the three capabilities of functional numeracy, practical and work-related knowledge and skills, and advanced specialist knowledge of mathematics [1].

According to The New Oxford American Dictionary in [2], “mathematics is the abstract science of number quantity and space. Abstract mathematical nature causes a relatively high degree of difficulty in students. The difficulty is apparent in the national exam results of SMP Negeri students in Karanganyar regency. The results of the national exam Mathematics is lower than other subjects, shown in table 1 [3], [4]. It shows that the results of math exams have decreased (Table 1)

| Table 1. Mathematics National Examination Result of Indonesia Junior High School Student for Last Two Years |
|---|---|---|---|---|
| Year | Bahasa (%)| Mathematic (%) | English (%) | Natural Science (%) |
| 2015 | 78.88 | 50.94 | 56.50 | 57.75 |
| 2016 | 78.15 | 48.27 | 53.66 | 58.76 |
The difficulty is not on all mathematics topics. Based on the results of the SMP National Exams [4], the absorption capacity for the quadrilateral topic in Karanganyar district is 49.55% and Indonesia's absorption is 50.55%. According to the data, it can be said that the absorption of quadrilateral material in Karanganyar Regency is lower than the absorption rate in Indonesia.

The low absorption is suspected because the learning process in quadrilateral material less than the maximum. This is in accordance with the results of interviews with several teachers in Karanganyar, it is obtained that the learning of mathematics is still using the lecture method. According to Hwang, in traditional education environments, geometry is most commonly taught using text, 2D image and mathematical formulas. For area topics, such teaching methods are not highly effective [5].

One of the learning model that is expected to improve mathematics achievement is cooperative learning model. According to [6], cooperative learning is instructional methods in which teachers organize student into small group, which then work together to help one another learn academic content. The effectiveness of cooperation are positive interdependence, individual accountability, promotive interaction, the appropriate use of social skills, and group processing [7]. There are many strategies in cooperative learning such as Student teams-Achievement Division, Team-Game-Tournament (TGT), Jigsaw, Learning Together etc., but the researcher was interested in Group Investigation (GI). The class in GI is divided into several groups that study in a different phase of a general issue. The study issue is then divided into working sections among the members of the groups. Students pair up the information, arrangement, analysis, planning and integrate the data with the students in other groups [8]. Group investigation nonetheless offers students the opportunity to take ownership of their own learning and to demonstrate their knowledge and understanding [11]. The principle of investigation on the steps in the GI learning model requires students to be able to present problems and find strategies in solving mathematical problems. In addition, the GI learning model allows students to build their own knowledge. The six steps of the GI model by Sharan in [9] can be seen in Table 2.

| Steps of GI | Learning Activities |
|-------------|---------------------|
| Step 1      | Class identifies sub-topics and organizes research groups |
| Step 2      | Groups plan their research work |
| Step 3      | Group implement their research work |
| Step 4      | Groups plan their research work |
| Step 5      | Group present their research work |
| Step 6      | Teacher and students assess presentations |

In this study, researchers modified GI with scientific approach. The need to modify the type of GI cooperative model with scientific approach because in practice the GI learning the students are usually only given the problems in the form of a booklet to be done or complete the sentence incomplete. With a scientific approach, the students are given authentic and challenging problems so that rise curiosity and encourage the students to work together to find solutions. Material of quadrilateral is a material that can be presented in authentic problems and applied in daily life. Learning GI with scientific approach is expected to facilitate students' knowledge effectively on the material of quadrilateral. This is because the GI with scientific approach learning gives the students the opportunity to solve the real problems scientifically. The teachers are no longer dominate the class, but only direct and motivate the students to learn independently and develop a sense of responsibility so that they can be active in solving real problems of daily life in groups. Learning activities through a scientific approach that is observing, questioning, experimenting, associating and communicating [10]. The steps of the core activities on the GI with scientific approach model can be seen in Figure 1.

Based on the explanation above, the researcher is interested to implement GI learning model with a scientific approach. By applying the model modification is expected that learning objectives can be
achieved better. This is supported by several studies that have been done before, among others, research conducted by the Gangga [14], it is concluded that the mathematics achievement of students with GI learning model is better than PBL and learning directly on the material solid geometry with the flat side. Previous studies have shown that the GI learning model is better than conventional learning [15].

Selection of cooperative learning model of GI with scientific approach in the mathematics learning is expected to improve the achievement of learners especially in the material of quadrilateral. The aim of this research is to know the effectiveness of GI learning model with scientific approach. In this study, students are given worksheets related to quadrilateral material. Another class uses the learning model commonly used by teachers. The results of this study indicate that GI learning model with scientific approach produces better learning achievement than conventional model. GI learning model with scientific approach can be an alternative by teachers in quadrilateral material learning (Figure 1).

Figure 1. The Step of Core Activity on Group Investigation with Scientific Approach

2. Methods
The type of this research is quasi-experimental study. The design of this study was the randomization static group comparison design [12]. A group of subjects taken from the population are grouped into experimental and control groups. Experimental group using GI model with scientific approach in learning. Then both groups were given the post-test. The study design is illustrated in Table 3.

Table 3. The Randomization Static Group Comparison Design

| Group             | Treatment | Achievement Test |
|-------------------|-----------|------------------|
| Experiment Group  | X         | T                |
| Control Group     | -         | T                |

The research was conducted at Karanganyar regency, Indonesia. The population in this research is the students of grade 7th of junior high school. The research sample was taken using stratified cluster random sampling. Students are categorized into high, medium, and low. Then, from each school taken
one school. Two classes were taken randomly from each selected school category. First class as experiment class and second class as control class. The experiment group consisted of 96 students and a control group of 96 students.

In this research, there are one independent variables and one dependent variable. Learning model is as the independent variable and mathematics achievement is as the dependent variable. The instrument of this research is a mathematics achievement test. The test is used to collect the data about the students’ mathematics achievement. The test was given after the treatment. Content validity of the students’ mathematics achievement test was conducted by 3 experts. To measure the reliability of the mathematics achievement test, it used Kuder-Richardson technique. Data analysis techniques used in this research is a one-way analysis of variance with same cells. The level of significant is $\alpha = 0.05$.

Hypothesis testing can be performed if the data is normally distributed and has the same variance. Normality test using Lilliefors method. Table 5 shows the normality test results of mathematical achievement test data for each group with a significance level of 5%. Based on table 4 it can be seen that in the experimental group, $L_{obs} = 0.05$ less than $L_{table} = 0.05 = 9$ and in the control group $L_{obs} = 0.08$ less than $L_{table} = 0.09$. This means that $H_0$ is not rejected in each group. So it can be concluded that the experimental group and the control group are normally distributed.

Homogeneity test is conducted to find out whether the mathematical achievement data has the same variance or not. Homogeneity test using Bartlett method. Table 6 shows homogeneity test results between groups with a significance level of 5%. Based on Table 6 it can be seen that $\chi^2_{obs} = 0.92$ is less than $\chi^2_{table} = 3.841$. This means $H_0$ is not rejected. So it can be concluded that the experimental group and the control group have the same variance.

3. Result and Discussion

The experimentation of learning using GI was conducted for 8 meetings, at the ninth meeting conducted a learning achievement test. Data of mathematics achievement test is presented in Table 3. The results from Table 3 showed that the experimental group obtained a mean score of 54.74 and the standard deviation of 17.98 from the mathematical achievement test on quadrilateral material. The control group obtained a mean score of 40.85 and the standard deviation of 15.28 from the mathematical achievement test on quadrilateral material. Table 4 shows that the average student’s mathematics achievement of experimental group is higher than control group.

| Group      | N  | Mean | Std.Dev | Variance | Max Score | Min Score |
|------------|----|------|---------|----------|-----------|-----------|
| Experimental | 96 | 54.74 | 17.98   | 323.47   | 96        | 12        |
| Control    | 96 | 40.85 | 15.28   | 233.58   | 72        | 8         |

Table 4. The Data of Students’ Mathematics Achievement

| Group      | $L_{obs}$ | $L_{table}$ | Decision Test | Conclusion |
|------------|-----------|-------------|----------------|------------|
| Experimental | 0.05      | 0.09        | $H_0$ is not rejected | Normal    |
| Control    | 0.08      | 0.09        | $H_0$ is not rejected | Normal    |

Table 5. The Result of Normally Test of Mathematics Achievement

| Test                      | k  | $\chi^2_{obs}$ | $\chi^2_{table}$ | Decision Test | Conclusion |
|---------------------------|----|----------------|-------------------|----------------|------------|
| Mathematics Achievement   | 2  | 0.92           | 3.841             | $H_0$ is not rejected | Homogen    |
The summary of the results of variance analysis is presented in Table 6 below. Based on Table 7 it can be seen that $\chi^2_{\text{obs}}$ is less than $\chi^2_{\text{table}}$, so $H_0$ is rejected. This means that GI learning model with scientific approach gives different effect on mathematics achievement. To know which learning model that gives better effect can be seen from the mean. Based on Table 7, the average experimental group is 54.74 and the control group average is 40.85. So it can be concluded that GI learning model with scientific approach produces better mathematics achievement than conventional learning model.

| Source           | S.S    | D.F | M.S.S | $F_{\text{obs}}$ | $F_{0.05}$ | Decision Test |
|------------------|--------|-----|-------|------------------|------------|----------------|
| Learning Model   | 9268.52| 1   | 9268.52| 33.28            | 3.38       | $H_0$ rejected |
| Error            | 52919.96| 190 | 278.53| -                | -          | -              |
| Total            | 62188.48| 191 | -     | -                | -          | -              |

4. Conclusion
Based on the results of data analysis and discussion, it can be concluded that the students taught using GI learning model with scientific approach have better mathematics achievement than the students taught using conventional learning model. In quadrilateral learning, GI learning model with scientific approach is more effective than conventional learning model, so that GI learning model with scientific approach can be used as an alternative by teacher in learning mathematics.

For further research, it can examine the effect of GI learning model with scientific approach on other materials and can modify GI learning model with other learning approaches.

References
[1] Ernest, P 2015 *International Journal of Education in Mathematics, Science and Technology* 3 187
[2] Khait, A 2005 *Science & Education* 14 137
[3] BSNP 2015 *Laporan Hasil Ujian Nasional Tahun Pelajaran 2014/2015* (Jakarta: Kemdikbud)
[4] BSNP 2016 *Laporan Hasil Ujian Nasional Tahun Pelajaran 2015/2016* (Jakarta: Kemdikbud)
[5] Hwang, W Y, Jia-Han S, Yueh-Min H, and Jian-Jie D 2009 *Journal of Educational Technology & Society* 12 229
[6] Slavin, R E 2011 *Instruction Based on Cooperative Learning* in *Handbook of Research on Learning and Instruction* ed REMayer & PAAlexander (New York: Taylor & Francis) pp 344-360
[7] Johnson, D W and Johnson R T 2009 *Educational researcher* 38 365
[8] Akcay N and Doymus K 2012 *Journal of Educational Sciences Research* 2 109
[9] Damini M and Surian A 2013 *Journal of Co-operative Studies* 46 24
[10] Hosnan M 2014 *Pendekatan Saintifik dan Kontekstual dalam Pembelajaran Abad 21* (Bogor: Ghalia Indonesia)
[11] Mitchell M G, Montgomery H, Holder M, and Stuart D 2008 *Alberta Journal of Educational Research* 54 388
[12] Budiyono 2003 *MetodePenelitianPendidikan* (Surakarta: UNS Press)
[13] Budiyono 2016 *StatistikauntukPenelitian* (Surakarta: UNS Press) pp 195–8
[14] Gangga U W A 2015 *Jurnal Elektronik Pembelajaran Matematika* 2 64-74
[15] Adora NM 2014 *International Journal of Humanities and Management Sciences* 2 146