Clustering based on sociometry in Pythagoras theorem

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Abstract. Student learning in groups is one way of organizing students in the classroom. In student learning in groups, teachers can provide assistance or guidance to group members more intensively. The grouping of students should be based on criteria designed according to the needs of students. Also, the formation of groups based on these criteria should be submitted to students, and if it is deemed necessary to make changes, the teacher should provide direction. This study aims to determine the learning outcomes of students in learning the Pythagoras Theorem by grouping based on sociometry. The subjects of this study were VIII grade students of State MTs Walisongo, Tegalwangi Jember, while for the sample of this study were Class VIII-D and Class VIII-E. This type of research is experimental research. The analysis of the research used the two independent sample t-test. The result obtained Sig-value of 0.002 which is smaller than 0.05 for the value of t of -3.172. It is concluded that the mean experimental class is not the same as the control class mean.

1. Introduction

In the learning process, a teacher needs a way of grouping students into several study groups. The choice of group members is adjusted to the desires of the students, learning friend in groups. The groups became the group that good social relations. Individual social relations can be measured by a method in psychology is called sociometry. Moreno [6] defined sociometry as "the inquiry into the evolution and organization of groups and the position of individuals within them. By sociometry, data obtained matches the relationships or desires of individuals in the group. Furthermore, Vajari [8] wrote that Sociometry has tools for measuring, exploring and developing relationships. Using data from these tools, group members participate in group development by reflecting on and examining their own interpersonal and group behavior. Using interactive learning methods to explore what is happening in particular relationships, perceptions, and misperceptions, group members realize that they are not alone and that they are part of a shared dynamic.

Bakkaloglu [2] compared of the loneliness levels of primary student according to their sociometric status. He used students Information Form, Social Skills Rating System-Teacher Form, Children’s Loneliness Scale and Peer Nomination Form. Bahar, et.al [1] investigated the effects of gender, perceived social support and sociometric status on academic success. He found that gender, perceived familial support and sociometric status have predicted 15% of academic success. Child and Nind [4] offered a critique of sociometries as a ubiquitous mwthod of measuring social relationship among children in social groups such as school classes. Furthermore, Gutierrez, et.al [5] used sociometric for the multiple team formation problem. Sabin, et.al [7] conclude that sociometric test can help to define cohesion (whether a group is united or divided), group preferences for the captain or other social problems in the group. In the paper’s Bansal [3], the sociometric assessment method that has been shown to be effective in educational. In this procedure, teachers rank the children in their classroom
who behavior problems. The use of teacher rankings serves as identifying children who may need additional assessment.

One way of organizing students in cooperative learning methods is grouping students. Mathematics learning is implemented by grouping students. One way of grouping student based on sociometry. This research aims to determine differences in learning outcomes between students grouped by sociometry and students grouped not based on sociometry of the Pythagoras Theorem.

2. Methods

This research used an experimental method. The pattern of the experimental method used is the post-test only design control-group pattern. Both the experimental class and the control class were only subjected to a post-test without a pre-test. The results of the pre-test experimental class and control class are assumed to be the same so that it is enough to compare the post-test results only between the two groups. The sample in this research was selected students of class VIIID and VIIIE, respectively 39 and 40 students. The control class is VIIID and the experimental class is VIIIE. The selection of the control class and the experimental class use of normality test and homogeneity test.

The data collection techniques used in this research are:

(1) Sociometry questionnaire

Sociometry questionnaire is used to group students into several study groups based on their social relationships with friends. They choose to study with friends. The sociometric questionnaire uses a nominative type.

(2) A test.

The test used to see the mathematics learning outcomes of students after the learning process by holding a final test.

The data obtained in this study were analyzed using:

1) Independent Technique Sociogram Analysis.

Independent techniques sociogram analysis is used for the formation of study groups before the learning process by grouping based on sociometry. The formation of group members is based on filling in the sociometric questionnaire. The results of filling out the questionnaire tabulated in the form of sociometric matrices. Then it analyzed by sociogram analysis of independent techniques.

2) Inductive Statistics

Inductive statistics are used to give conclusions whether there are similarities of the variance and similarities of the mean between the control class and the experimental class. The Levene's Test is used to test the variance homogeneity of two independent samples and the independent samples t-test is used to test the difference of control class mean and experimental classes. Normality test using the Kolmogorov-Smirnov's test.

3. Result and Discussion

Study groups are formed using independent sociogram techniques. The formation of group members is based on filling in the sociometric questionnaire. The results of filling out the questionnaire tabulated in the form of sociometric matrices. Then, it analyzed by sociogram analysis of independent techniques. The student's name is replaced by the attendance number, then the number is placed independently so that it is easily connected between students who choose with students selected and it can see groups formed in the class. The formation of study groups in this study is not based on the gender of the student, data tabulated in the sociometry and sociogram matrix analysis. Making independent sociogram techniques is done repeatedly to get a sociogram so that a study group is formed. Sociometry questionnaire consists of two questions, namely friends are liked as study partners and friends are not liked as study partners. Sociometry questionnaire data through some stages of data processing, namely matriculation, sociogram making and independent techniques sociogram analysis or the formation of student groups based on sociogram and matrix analysis.
Figure 1. Sociogram for student of the experimental class

Figure 1 describes the sociogram for students from the experimental class (VIIIE). Relationships between students are described by lines, students are denoted by numbers and two intersecting relationships are represented by dots. Experimental class, 40 students are divided into 8 groups with 5 students. Figure 1 can be formed 8 configuration diagrams for group formation. Some examples of configuration diagrams are shown in Figure 3.

The second data analysis is using inductive statistics for comparison of mathematics learning outcomes. Inductive statistics are used to give conclusions whether there are similarities of the variance and similarities of the mean between the control class and the experimental class. The Levene’s Test is used to test the variance homogeneity of two independent samples and the independent samples t-test is used to test the difference of control class mean and experimental classes. Normality test using the Kolmogorov-Smirnov’s test. The learning outcome data used is the value of the final test results data on the subject of the Pythagoras Theorem.

Normality tests were carried out on the final test value on the subject of Linear Equation System Two Variables. This research used the One-Sample Kolmogorov-Smirnov Test. The following table is the normality test for the experimental class and the control class. The experimental class is VIIIE and the control class is VIIID.

| Normality Test for the Experimental Class and the Control Class | Kelas VIIID | Kelas VIIIE |
|---------------------------------------------------------------|------------|------------|
| N                                                             | 39         | 40         |
| Normal Parametera,b                                          |            |            |
| Mean                                                          | 44.0256    | 45.7250    |
| Std. Deviation                                                | 6.94901    | 6.23056    |
| Most Extreme Differences                                      |            |            |
| Absolute                                                      | .156       | .207       |
| Positive                                                      | .156       | .207       |
| Negative                                                       | -.102      | -.115      |
| Kolmogorov-Smirnov Z                                          | .971       | 1.312      |
| Asymp. Sig. (2-tailed)                                         | .302       | .064       |

a. Test distribution is Normal.
b. Calculated from data.

Based on Table 1, data obtained Sig-value 0.302 and 0.064 respectively for data VIIID (the control class) and VIIIE (the experimental class). The two Sig-values were greater than the significant level of 0.05 so it was concluded that the data of the two classes were normally distributed.
Homogeneity test to determine the similarity of population variance. The test used is the Levene’s Test. The homogeneity test of the experimental class and the control class is presented in the following table.

**Table 2. Levene’s Test**

| Equal variances assumed | F    | Sig. | t    | df | Sig. (2-tailed) | Mean Diff | Std Err Diff | 95% CI of the Difference |
|-------------------------|------|------|------|----|-----------------|-----------|--------------|-------------------------|
| All Akhir              | 0.227| 0.635| -1.145| 77  | 0.256           | -1.694    | 1.48409      | -4.65456 - 1.25534      |
| Equal variances not assumed | 0.227| 0.635| -1.145| 75.638 | 0.256           | -1.694    | 1.48616      | -4.65953 - 1.26093      |

The independent test table also shows the test results of the test. Price F is obtained 0.227 with a Sig-value of 0.635. Sig-value of 0.635 is greater than the standard significance level of 0.05. Thus, it can be concluded that the variance of the experimental class is the same as the control class variance. The t-Test procedure for two independent samples is used to test the hypothesis of the similarity of two means. The data for similarity of the mean was the final test data values of the Pythagoras Theorem for the control class and the experimental class.

**Table 3. Independent Samples Test**

| Equal variances assumed | F    | Sig. | t    | df | Sig. (2-tailed) | Mean Diff | Std Err Diff | 95% CI of the Difference |
|-------------------------|------|------|------|----|-----------------|-----------|--------------|-------------------------|
| All Akhir              | 0.227| 0.635| -1.145| 77  | 0.256           | -1.694    | 1.48409      | -4.65456 - 1.25534      |
| Equal variances not assumed | 0.227| 0.635| -1.145| 75.638 | 0.256           | -1.694    | 1.48616      | -4.65953 - 1.26093      |

Based on Table 3, obtained Sig-value of 0.002 which is smaller than 0.05 for the value of t of -3.172. It concludes that the mean experimental class is not the same as the control class mean. In other words, student learning outcomes with grouping based on sociometry are higher than student learning outcomes without sociometry. The mean final test scores of the control class and experimental class are presented in the following Figure 2.

**Figure 2. Qualification of test score and the average of test score**

Based on Figure 2, it can be seen significant differences the control class and the experimental class. The control class has 22 students failed and the experimental class has 5 students failed. This shows the importance of selecting group members in the learning process. The group formation can be done by sociometry.

By way of distributing sociometry questionnaires to students, then the researcher get groups according to the rules of sociometry and the group structure of relationships between good individuals. The direction of relationships built in groups is based on the direction of relationships between group
members, the more two-way relationships or reciprocal relationships are built, the group has a good relationship structure. Conversely, if the direction of the relationship is only one direction or even there is no relationship, then it can be pointed out that the group has an unfavorable group relations structure.

Based on Figure 1, the 8 groups formed are presented in the Table 4. Groups that have the best direction and relationship structure are expected to have good learning outcomes. With the thought that the group members help each other, work together and are responsible for the group. Each group member has the same responsibilities.

**Table 4. Frequency of member relations with the final test score for each group the experimental class**

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| Group | Member of Group | Value  | Mean | Frequency of relationships |
|-------|----------------|--------|------|---------------------------|
|       |                |        |      | 2 direction | 1 direction |
| I     | 10             | 63,64  | 61,82| 5           | 2           |
|       | 17             | 69,70  |      |             |             |
|       | 20             | 48,48  |      |             |             |
|       | 24             | 63,64  |      |             |             |
|       | 29             | 63,64  |      |             |             |
| II    | 6              | 66,67  | 65,46| 4           | 3           |
|       | 13             | 60,61  |      |             |             |
|       | 19             | 60,61  |      |             |             |
|       | 26             | 72,73  |      |             |             |
|       | 37             | 66,67  |      |             |             |
| III   | 8              | 66,67  | 59,40| 8           | 1           |
|       | 34             | 72,73  |      |             |             |
|       | 35             | 69,70  |      |             |             |
|       | 38             | 51,52  |      |             |             |
|       | 39             | 36,36  |      |             |             |
| IV    | 4              | 69,70  | 57,58| 4           | 2           |
|       | 7              | 69,70  |      |             |             |
|       | 9              | 60,61  |      |             |             |
|       | 23             | 39,39  |      |             |             |
|       | 25             | 48,48  |      |             |             |
| V     | 5              | 69,70  | 67,28| 2           | 5           |
|       | 21             | 51,52  |      |             |             |
|       | 22             | 78,79  |      |             |             |
|       | 30             | 60,61  |      |             |             |
|       | 32             | 75,76  |      |             |             |
| VI    | 1              | 54,55  | 53,94| 2           | 4           |
|       | 2              | 60,61  |      |             |             |
|       | 12             | 57,58  |      |             |             |
|       | 18             | 54,55  |      |             |             |
|       | 33             | 42,42  |      |             |             |
| VII   | 3              | 62,64  | 61,02| 1           | 5           |
|       | 14             | 66,67  |      |             |             |
|       | 27             | 60,61  |      |             |             |
|       | 28             | 51,52  |      |             |             |
|       | 36             | 63,64  |      |             |             |
| VIII  | 11             | 72,73  | 70,91| 2           | 2           |
|       | 15             | 81,82  |      |             |             |
|       | 16             | 63,64  |      |             |             |
|       | 31             | 63,64  |      |             |             |
|       | 40             | 72,73  |      |             |             |
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The example of relationship configuration in Table 4 can be presented in Figure 3. From the direction of the relationship of each group member, it is expected that at the end of the mathematics learning the subject of the Pythagoras Theorem which gets the best score is group third. The direction of the relationship built by its member of the third group has 8 relations in two directions and 1 relation in one direction. But in reality group third does not describe the goodness of a group built by the relations in two directions, this fact can be seen from the acquisition of final test scores. In third group, there is still one member who gets a less grade. Independent techniques sociogram analysis of third group is presented in Figure 3.

![Figure 3. The configurugation of: (a) a third group; (b) an eighth group; (c) a seventh group](image)

Based on Figure 3, the configuration of a third group relations is strong because almost all group members make reciprocal elections. The configuration has 8 relations in two directions and 1 relation in one direction. The configuration of an eighth group has 2 relations in two directions and 2 relations in one direction.

There is a third group that has a bad direction and relationship structure. This can lead to an expectation that the acquisition of the final test scores from the group is not satisfactory. It turns out that there are seventh and eighth groups that get better grades. In the seventh group, the direction and structure of the relationship are built with only one relation in two directions and five relations in one direction. In addition to the seventh group of interesting things also happened in the eighth group, this group was built only with two relations in two directions and two relations in one direction, but in this group, there were members who obtained very good qualifications and other members obtained grades with qualifications good and sufficient qualifications.

In general, based on the results of data analysis obtained in the study on the students' final test, there were differences in the results of scores between the class with sociometry and the class without sociometry. There are differences in the average, the control class has an average of 50.43 and the experimental class has an average of 62.20, followed by an increase in the percentage of qualifications the final test score is better for the experimental class than the control class. The data is reinforced by the results of the t-test obtained -3.172 danSig-value 0.002. Because the Sig-value is smaller than the significant level of the SPSS program. Base on t-test accepts the alternative hypothesis stated the control class means is not the same as the experimental class means.

### 4. Conclusion

The result obtained Sig-value of 0.002 which is smaller than 0.05 for the value of t of -3.172. It is concluded that the mean experimental class is not the same as the control class mean. In other words, student learning outcomes with grouping based on sociometry are higher than student learning outcomes without sociometry. We can conclude that there are significant differences in learning outcomes of mathematics between students grouping based on sociometry and students without sociometry.

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