Cooperative learning model with high order thinking skills questions: an understanding on geometry

P P Sari*, Budiyono and I Slamet
Graduate Program of Mathematics Education, Teacher Training and Education Faculty, Sebelas Maret University, Ir. Sutami Street 36A Keningan, Jebres, Surakarta City, Central Java, Indonesia 57126

*Corresponding author: putrigoe@gmail.com

Abstract. Geometry, a branch of mathematics, has an important role in mathematics learning. This research aims to find out the effect of learning model, emotional intelligence, and the interaction between learning model and emotional intelligence toward students’ mathematics achievement. This research is quasi-experimental research with 2 x 3 factorial design. The sample in this research included 179 Senior High School students on 11th grade in Sukoharjo Regency, Central Java, Indonesia in academic year of 2016/2017. The sample was taken by using stratified cluster random sampling. The results showed that: the student are taught by Thinking Aloud Pairs Problem-Solving using HOTs questions provides better mathematics learning achievement than Make A Match using HOTs questions. High emotional intelligence students have better mathematics learning achievement than moderate and low emotional intelligence students, and moderate emotional intelligence students have better mathematics learning achievement than low emotional intelligence students. There is an interaction between learning model and emotional intelligence, and these affect mathematics learning achievement. We conclude that appropriate learning model can support learning activities become more meaningful and facilitate students to understand material. For further research, we suggest to explore the contribution of other aspects in cooperative learning modification to mathematics achievement.

1. Introduction
Geometry is a branch of mathematics concerned with point, straight line, plane figures, space, spatial figures, and the relations between them [1]. Ability student to understand geometry subject less than ability to understand the other subject in mathematics [2]. Various efforts made by the government to improve the quality of mathematics education in the Indonesian. But efforts that have been done before is not enough to showing the satisfy result. In this case, can see another achievement is even more apprehensive on PAMER UN, application about the results of national examination in Indonesia. Student achievement is also still apprehensive according to PAMER’s UN reported data in 2016 is 53,51 on the average score of mathematics national examination in the academic years of 2015/2016 either in state or private high school Sukoharjo District. Student get mastery absorption of circle with indicators of determining the tangent circle of the district level in the amount of 39,15% from 74.608 students. The average score indicates that students’ absorption in circle subject is still low. The low achievement of the students is possibly caused by several factors that affect learning achievement.
Slameto [3] states that factors which affect learning are divided into two factors namely internal factors and external factors.

Factors within students also affect the learning achievement. Goleman [4] states that there are students who have an IQ above average but they get a relatively low learning achievement while there are students with moderate IQ, can achieve relatively high learning achievement. Therefore, intelligence is not the only factor that determines someone's success, because there are other factors that influence, one of them is emotional intelligence (EI). In students’ learning process, both intelligence are very necessary. According to Goleman [5], emotional intelligence skills work in synergy with IQ. Both intelligence are complementary to one another. The balance between IQ and EI is the key to student success at school. This is in line with research conducted by Nwadimigwe and Obieke [6] showed that there is a positive relationship between EI and academic achievement so that the development of emotional intelligence will improve students’ performance.

Students’ activeness in the learning process greatly affects the success of student learning. According to Joyce, et al. [7] A learning model is a plan or a pattern used as a guide in planning learning in the classroom and for determining learning devices. Thus, the learning activity is an aimed activity that arranges systematically and can fulfill students’ needs to be more motivated in learning and develop students’ potential that can improve students’ achievement. The cooperative learning model is expected to support students’ emotional intelligence. According to Johnson & Johnson, the main objective of cooperative learning is to maximize student learning for improving academic achievement and understanding both individually or in groups. Because students work in a team, it can naturally improve relationships among students from different ethnic backgrounds and abilities, develop group process skills and problem-solving [8]. Cooperative learning model includes cooperative learning model Thinking Aloud Pairs Problem Solving (TAPPS) and Make A Match (MAM).

According to Benham [9], TAPPS was first introduced by Claparade, which was later used by Bloom and Broader on their study about problem-solving processes at college students. According to Pate, Wardlow, and Johnson [10], TAPPS is a learning model for improving problem-solving skills through verbal inquiry and extension. According to Lochhead & Whimbey [10], TAPPS has certain characteristics that students in pairs solve a problem where students share the role as a problem solver and listener by following a certain rule. A Pate & Miller study [11] mentioned that TAPPS could help students by organizing and regulating in information processing to improve their problem-solving performance. Conceptually, this learning focuses on improving student performance on complex problem-solving activities by utilizing TAPPS as a strategy for developing metacognitive thinking in problem-solving.

According to Lie [12], MAM learning model or finding a partner was developed by Lorna Curran (1994). MAM is one of the cooperative learning models by finding a partner while learning about a particular concept or topic in a fun atmosphere and it can be used for all lessons and levels [13]. Huda [14] suggests that the characteristics of MAM are group members thinking about questions or answers in groups, then each member looks for a pair of cards and exchanges thoughts with his or her partner within time limitation. According to Huda [14] and Curran [15] the purpose of MAM, among others are material understanding, material excavation, and edutainment. Besides, the advantages of MAM model according to Wahab is a learning system that prioritizes social skills, especially cooperative ability, as well as the ability to think quickly through looking for a partner game with assisted cards.

Related research namely, Ulfa [16] showed that TAPPS compared with TAI (Teams Assisted Individualization) and Awari [17] show that MAM compared with TPS (Think Pair Share). In this study, the difference of this study with the other study is combination of TAPPS and MAM using High Order Thinking Skills (TAPPS and MAM HOTs questions). HOTs questions [18,19] can close a shortage of TAPPS and MAM during discussions because it can improve students problem solving ability to help students solve the math problem solving questions. Erlina [20], the study found a significant relationship between students achievement and problem solving ability.
Based on the problems explained above, then the aim of this research is to find out the effect of TAPPS using HOTs questions and MAM using HOTs questions. In this study, we also discuss about the effect of emotional intelligence toward students’ mathematics achievement. Besides, we are to find out the interaction between learning model and emotional intelligence toward students’ mathematics achievement.

2. Methods
This research is a quasi-experimental research to know the difference of each learning model influences to student achievement. The research design used in this study with a 2x3 factorial design. In this study, there are two variables observed namely a independent variables (learning model and emotional intelligence) and a dependent variable (learning achievement). The population of this research is all students of class XI of State Senior High School in Sukoharjo District of Central Java Indonesia in the academic years of 2016/2017 using KTSP curriculum. KTSP curriculum (Curriculum Unit Level Education) is operational curriculum drawn up and implemented in each unit of education. The sample of this research consisted of 179 students. Sampling was done by stratified cluster random sampling technique. Based on national examination data of 2014/2015, schools are grouped into three categories namely high, moderate, and low. In each school category, one school was taken. The sample schools are SMAN 3 Sukoharjo, SMAN 1 Kartasura, and SMAN 1 Nguter. In each school, two classes were taken. Those classes consist of one class used TAPPS learning model, and another class used MAM learning model.

Methods of data collection in this study consist of documentation method, questionnaire, and test. The instrument used in this research is a test to obtain data of mathematics learning achievement and questionnaire to obtain data of students’ emotional intelligence. Testing the test instrument consists of validity test, reliability, discriminating power, the use of distracters, and difficulty level. The test of questionnaire instrument consists of validity, reliability, and discriminating power. Before the analysis of variance, first of all, do the prerequisite test using the normality test by Liliefors method and homogeneity test by Bartlett method. Testing the balance uses the t-test. Hypothesis test uses two-way ANOVA with unequal cell then continued multiple comparison test with Scheffe method [21], this is done if the null hypothesis is accepted.

3. Results and Discussion
Student's mathematics achievement test is 25 items of multiple choice given to the experimental class students. The results of the pre-requisite test on initial data and learning achievement conclude that all samples come from normally distributed populations and populations have the same variance. This can be shown in the results of normality and homogeneity test on initial data and learning achievement. Based on the result of equilibrium test, it can be concluded that the sample of the population of the learning model group is in a balanced state. Furthermore, two-way ANOVA test with different cells was performed on the learning achievement data. A summary of analysis variance of mathematics achievement learning students is presented in Table 1 until Table 3.

3.1. Normality test
Normality test is used to know whether the data are in normal distribution or not. In this research, normality test used Liliefors method. The result of normality test at the significance level of 5% is presented in Table 1 below.

| Table 1. The Normality Test Result of Learning Achievement Data |
|---------------------------------------------------------------|
| Groups                      | L_{obs} | L_{table} | Conclusion |
| Experiment 1 (TAPPS using HOTs questions)            | 0.0907  | 0.0991    | Normal    |
| Experiment 2 (MAM using HOTs questions)              | 0.0718  | 0.1003    | Normal    |
| High Emotional Intelligence                            | 0.0872  | 0.1010    | Normal    |
| Moderate Emotional Intelligence                       | 0.0829  | 0.0924    | Normal    |
| Low Emotional Intelligence                            | 0.0740  | 0.1067    | Normal    |
Based on Table 1, it shows that $L_{\text{obs}}$ for each sample is not exceed from $L_{\text{tab}}$. Therefore, $H_0$ is accepted, it means that each sample is from normal distributed populations.

### 3.2. Homogeneity test

Homogeneity test is used to know whether the research population has the same variance or not. In this research, homogeneity used Bartlett method. The result of homogeneity test at significance level of 5% is presented in Table 2 below.

| Groups                      | K | $X^2_{\text{obs}}$ | $X^2_{(0.05,k-1)}$ | Decisions | Conclusion                  |
|-----------------------------|---|-------------------|---------------------|-----------|----------------------------|
| Learning Model              | 2 | 0.4669            | 3.841               | $H_0$ is accepted | Homogeneity variance populations |
| Emotional Intelligence      | 3 | 0.7484            | 5.991               | $H_0$ is accepted | Homogeneity variance populations |

Based from Table 2, it shows that $X^2_{\text{obs}} < X^2_{\text{table}}$, it can be concluded that all groups have the same variance or homogeneity.

### 3.3. Analysis Test Using Two-Way Variance Analysis with Not Equal Cell

| Source                      | JK     | Df | RK   | $F_{\text{obs}}$ | $F_{\text{table}}$ | Conclusion         |
|-----------------------------|--------|----|------|------------------|---------------------|---------------------|
| Learning Model (A)          | 1098,3727 | 1   | 1098,3927 | 7,7368 | 3.84 | $H_{0A}$ is rejected |
| Emotional Intelligence (B)  | 4148,6520 | 2   | 2092,3260 | 14,7378 | 3   | $H_{0B}$ is rejected |
| Interaction (AB)            | 3391,4946 | 2   | 1695,7473 | 11,9444 | 3   | $H_{0AB}$ is rejected |
| Error                       | 24702,8214 | 174 | 141,9702 | -     | -   | -                  |
| Total                       | 33377,3606 | 179 | -    | -     | -   | -                  |

Notes are $H_{0A}$ is a difference in learning math achievement between each learning model, $H_{0B}$ is a difference in mathematics learning achievement between each category of emotional intelligence, and $H_{0AB}$ is interaction in mathematics learning achievement between learning model and emotional intelligence.

Based on the summary of hypothesis test using two-way variance analysis with not equal cell and at the significance level of 5% in Table 3 can be concluded as follows in the main effect A (learning model), $F_a = 7.7368 > F_{\text{tab}} = 3.84$ so that $F_a \in DK$ which means that $H_{0A}$ is rejected and there is a difference in mathematics learning achievement between students taught by TAPPS using HOTs questions and MAM using HOTs questions learning model. In the main effect B (emotional intelligence level), $F_b = 14.7378 > F_{\text{tab}} = 3$ so that $F_b \in DK$ which means that $H_{0B}$ is rejected and there is a difference in mathematics learning achievement between students having high, moderate, and low emotional intelligence. In the interaction effect of AB (learning model and emotional intelligence level), $F_{ab} = 11.9444 > F_{\text{tab}} = 3$ so that $F_{ab} \in DK$ which means that $H_{0AB}$ is rejected. This means there is interaction between learning model and emotional intelligence students toward mathematics learning achievement.

A Summary of cell and marginal average on each learning model and emotional intelligence students is presented in Table 4. The marginal average is score from 0 to 100.
### Table 4. The Marginal Average of Learning Model and Emotional Intelligence

| Learning Model | Emotional Intelligence | Marginal Average |
|----------------|------------------------|------------------|
|                | High       | Moderate | Low  |         |
| TAPPS Using HOTs questions | 77.67     | 73.71    | 58.43| 69.55   |
| MAM Using HOTs questions   | 63.14     | 55.87    | 57.89| 58.97   |
| Marginal Average           | 70.41     | 64.79    | 58.16|         |

Based on the result of ANOVA calculation, it shows that $H_{0A}$ is rejected. If $H_{0A}$ is rejected, it is not necessary to do multiple comparison tests between rows (between learning model) because there is two categories. Based on marginal average in Table 2, TAPPS using HOTs questions learning model provides better mathematics achievement than MAM using HOTs questions. TAPPS using HOTs questions supports students to explain all problem-solving ideas, check their understanding between others, and understand the steps of problem-solving. Learning that is had can be more meaningful so that TAPPS using HOTs questions learning model provides better mathematics achievement than MAM using HOTs questions learning model. This is in line with research conducted by Benham [9] showed that TAPPS learning model provides better mathematics achievement than other group.

Based on the result of ANOVA calculation, it shows that $H_{0B}$ is rejected. Because $H_{0B}$ is rejected, it is necessary to do multiple comparison tests between columns (between emotional intelligences) by using Scheffe method because there is three categories. A Summary of multiple comparison tests between columns is presented in Table 5.

### Table 5. The Summary of Multiple Comparison Tests between Column

| $H_0$      | $F_{obs}$ | $F_{tab}$ | Conclusions     |
|------------|-----------|-----------|-----------------|
| $\mu_1 = \mu_2$ | 7.16      | 6.00      | $H_0$ is rejected |
| $\mu_1 = \mu_3$ | 19,1843   | 6.00      | $H_0$ is rejected |
| $\mu_2 = \mu_3$ | 15,1967   | 6.00      | $H_0$ is rejected |

Based from Table 5, $F_{obs} > F_{tab}$ so that $F_{obs} \in DK$ which means that $H_0$ is rejected. Based from Table 5 and marginal average in Table 4, it can be concluded that the mathematics learning achievement on high emotional intelligence is better than moderate and low emotional intelligence, the mathematics learning achievement on moderate emotional intelligence is better than low emotional intelligence. This is in line with the research conducted by Nwadinigwe and Obieke [6] showed that there is a positive relationship between emotional intelligence and academic achievement so that the emotional intelligence improvement will increase students performance. This is in line with research conducted by Oyewunmi, Osibanjo, & Adeniji [22] [23] [24] [25] [26] [27] [28] showed that found a positive connection between emotional intelligence and academic achievement so emotional intelligence students performed better in both tests and examinations. This is in line with research conducted by Maraichelvi & Rajan [29] showed that good emotional intelligence improved good academic achievement followed by category respectively because emotional intelligence could managed psychological barriers to learning activities in the classroom.

Then, it is necessary to use multiple comparison tests between cells in same row or column. A summary of this analysis is presented in Table 6.
Based from Table 5, \( F_{\text{obs}} > F_{\text{tab}} \) so that \( F_{\text{obs}} \in \text{DK} \) which means that \( H_0 \) is rejected and \( F_{\text{obs}} < F_{\text{tab}} \) so that \( F_{\text{obs}} \notin \text{DK} \) which means that \( H_0 \) is accepted.

Based on Table 6, it can be concluded that high, moderate, and low emotional intelligence have different results when they were taught by using TAPPS using HOTs questions and MAM using HOTs questions learning model. In students taught using TAPPS using HOTs questions learning model, high emotional intelligence students have mathematics learning achievement as good as moderate emotional intelligence, while high and moderate emotional intelligence have better mathematics learning achievement than low emotional intelligence. This is in line with research conducted by Goleman [5] showed that there are students who have an IQ above average but they get a relatively low learning achievement while there are students with moderate IQ, they can achieve relatively high learning achievement. Therefore, intelligence is not the only factor that determines someone's success, because there are other factors that influence, one of them is emotional intelligence. In students’ learning process, both intelligence are very necessary. According to Goleman [6], emotional quotient skills work in synergy with IQ. Both intelligence are complementary to one another. The balance between IQ and emotional intelligence is the key to student success at school. While according to Goleman [6], emotional intelligence itself is students’ ability to recognize their emotions, manage their emotions, motivate themselves, recognize the emotions of others (empathy), and the ability to build relationships (cooperation) with others.

TAPPS using HOTs questions and MAM using HOTs questions learning model provide different result in high, moderate, and low emotional intelligence. In high and moderate emotional intelligence, TAPPS using HOTs questions provides better mathematics learning achievement than MAM using HOTs questions. In low emotional intelligence students, TAPPS using HOTs questions provides mathematics learning achievement as good as MAM using HOTs questions learning model. This is in line with research conducted by Johnson [30] showed that emotional intelligence had significant role in academic achievement and group success because emotional intelligence managed stressful situations successfully.

Therefore, students’ learning achievement can be caused by the learning model applied by the teacher and the difference of emotional intelligence so that it is necessary to conduct a research to know an appropriate learning models, and the influence of emotional intelligence on the mathematics learning achievement especially on circle material.

4. Conclusion

According to the research findings, it could be concluded that: The student are taught by Think Aloud Pair Problem-Solving using HOTs questions provides better mathematics learning achievement than Make A Match using HOTs questions. High emotional intelligence students have better mathematics learning achievement than moderate and low emotional intelligence students, and moderate emotional intelligence students have better mathematics achievement than low emotional intelligence students. In
TAPPS using HOTs questions and MAM using HOTs questions learning model, high emotional intelligence students have mathematics learning achievement as good as moderate emotional intelligence students, while high and moderate emotional intelligence students have better mathematics learning achievement than low emotional intelligence students. In each category of high and moderate emotional intelligence students, TAPPS using HOTs questions learning model provides better mathematics learning achievement than MAM using HOTs questions learning model, and in low emotional intelligence students, TAPPS using HOTs questions learning model provides mathematics learning achievement as good as MAM using HOTs questions learning model. HOTs questions can improve students problem solving ability to help students solve the math problem solving questions. According to Erlina [20], the study found a significant relationship between students achievement and problem solving ability.

The interaction between learning model and emotional intelligence affect mathematics achievement. In conclusion, the finding show to use an appropriate learning model can support learning activities become more meaningful and facilitate students to understand material so students achievement improve significantly. Further research needs to be conducted to explore the contribution of other aspects in cooperative learning modification toward mathematics achievement.

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