Cooperative learning model using AFL to learn geometry based on creativity perspective

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Abstract. This study aims first to find out who has the better learning achievement among the groups of students learning by using the Students Team Achievement Division (STAD) model with Assessment for Learning (AFL), using STAD with experimental method, and using direct instruction to learn solid geometry. Second, this study aims to find out the students’ learning achievement based on their creativity level. Third, this study aims to explore the interaction between the learning model and the students’ creativity. We conducted this study at some Islamic junior high schools in Klaten, Indonesia. We administered both questionnaire and test to collect the data of learning achievement and creativity, and we used two-way ANOVA to analyse the data. The results suggest that the learning achievement of students who get STAD with AFL was better than the students who get either STAD or direct instruction, while the learning achievement of the students who get STAD was better than the direct instruction model. The learning achievement of students with high creativity was better than of students with medium or low creativity, while the learning achievement of students with medium creativity was better than of students with low creativity. Finally, there was an interaction between the factor of the learning model and the factor of students’ creativity.

1. Introduction
Mathematics learning has two objectives, namely material and formal objectives. The former is emphasizing mathematics application and mathematics skills, while the later is emphasizing reasoning and character building [1]. Mathematics becomes a required subject at every level of education, from elementary school to university level due to its contribution to the development of science and technology [1-4]. However, the quality of mathematics learning in Indonesia is still low [5-7].

The low average of mathematics scores in Indonesia can be seen from the results of the national examination. The data of the national examination result in 2016 shows that the students’ performance in Central Java, Indonesia, was far below the national average score of 51.8, especially in Klaten, one of the regencies in Central Java. The average national examination score of mathematics subjects for Islamic junior high school in Klaten is 36.50. Based on the topic, the students could only solve 48.75% problems of number theory, 45.98% of algebra, 42.49% of geometry, and 43.12% statistics. From the data, the topic with the lowest percentage of problems correctly answered was geometry [8].

We can take an example of the cone problem in the national examination data. The students were asked to calculate the volume of a cone if its diameter and its height are enlarged \( x \) times and \( y \) times respectively when the initial volume of the cone was given and the \( x \) and \( y \) are natural numbers less
than 5. Ironically, it was only 26.50% of the students who could solve it [8]. This phenomenon confirms the fact that the students’ performance in solid geometry was still low.

The students’ difficulties in learning solid geometry normally happened because of the lack of evidence, lack of apperception knowledge, poor reasoning skills, poor in understanding geometric concepts, lack of visualization skills, inappropriate teaching method, unavailability of teaching materials, and gender differences [9]. Besides, the students’ difficulties in learning were influenced by five factors, namely psychological, social, emotional, intellectual, and pedagogical factors. The selection of learning approach, for example, affects the students’ ability [10]. Three factors are affecting the student achievement, namely; (1) internal factors, such as the physical and spiritual condition of students, (2) external factors, such as environmental condition around students, and (3) pedagogical factors, such as the approaches and strategies used in teaching [11].

The learning model is a structural framework guiding the run of learning from the beginning to the end of the teaching process. Based on the theory of constructivism, learning is the result of the construction of student's activities [12]. Therefore, a learning model needs to be student-centered. One of the learning models suits this feature is a cooperative learning model. The cooperative learning model is a learning model that focused on the use of small groups of students to work together in maximizing learning conditions to achieve goals [13]. Cooperative learning model develops discussion and communication skills such that the students share their ability, create mutual learning, thinking critically, express opinion, give each other opportunities to share their ability, scaffolding, assess each other ability and role themselves and others.

Student Team Achievement Division (STAD) is one type of cooperative learning model by small groups consisting of 4 to 5 students heterogeneously. In the beginning, the teacher explains the learning outcomes, the teaching method, group activities, quizzes, and group awards [13]. To run STAD, we need to use a method to intertwine the interaction between teacher and student. In this research, we focused on the use of experiment method. The experimental method enables the students to find their answer of problems by conducting experiments. The experimental method is a method in providing opportunities to the students, whether individual or group, to be trained to perform a process or experiment. Through the experiment, the students will gain a meaningful learning experience so that the concepts will be more profound [14, 15].

To know the learning process is working effectively, we need a formative assessment. It is the assessment which aims to get feedback from the students [16]. In this paper, the formative assessment is called the Assessment for Learning (AFL). The AFL could provide a positive impact on the learning. For example, a teacher can do a formative assessment to provide feedback as soon as possible for students to get an appropriate conclusion. Short and brief assessments can be useful in highlighting the misunderstandings so that the teacher may choose a proper intervention [17, 18]. The application of AFL by teachers requires special pedagogical support in seeking and interpreting the evidence for use by students and the teachers to decide where the learners are in their learning, where they need to go next, and how best to get them here. The strategies in implementing AFL can be done through peer assessment [19-21].

In the learning process, the teacher needs to notify the student’s thinking level. In junior high school, most students (85.71%) can think in the concrete operational stage. Hence they faced difficulties in understanding abstract mathematical concepts [22]. Mathematics, so far, requires more creative thinking rather than memorization [23, 24]. Creativity is a product of creative thinking. Hurlock [25] said that creativity has various levels due to students possess different levels of intelligence. Student creativity includes three levels, namely, low creativity, medium creativity, and high creativity. Each level influences students’ achievement. Loewen [26] argued that submitting creative problems, the teacher can increase students the awareness that not all of the given problems only have one solution. This awareness can trigger and train their creativity in learning mathematics as one of the higher order thinking skill [27] — the higher their creative thinking, the higher their creativity.

This present study aims first to find out who has the better learning achievement among the groups of students learning by using the Students Team Achievement Division (STAD) model with Assessment
for Learning (AFL), using STAD without AFL, and using direct instruction to learn solid geometry. Second, this study aims to find out the students’ learning achievement based on their creativity level. Third, this study aims to explore the interaction between the learning model and the students’ creativity.

2. Method
The population in this research is the 9th-grade students of public and private Islamic junior high schools in Klaten in the 2017/2018 academic year. Among the population, we selected three schools in Klaten, that each represented the high, middle, and low level. In each school, we selected three groups, two of them were experiment groups, and one of them was a control group. The sampling method has been done by stratified cluster random sampling.

We did several stages in the sampling method. The first step was using the stratified technique. We grouped the population based on the schools’ ranking. We used the average score of the national examination as the grouping criteria. The average mathematics score (X̄) is 36.5 and the standard deviation (s) is 5.03. A school was categorized as high level (X̄t) when X̄t > X̄ + 0.5s = 36.5 + 0.5(5.03) = 39.01. A school was categorized as middle level (X̄s) when X̄t ≥ X̄s ≥ X̄ − 0.5s = 36.5 − 0.5 × 5.03 = 33.98. A school was categorized as low level (X̄r) when X̄r < X̄s.

The second step, based on the rank, we selected one school randomly from every group. There were MTs Muhammadiyah Trucuk represents the high-level school group, MTs Negeri Cawas represents the middle-level school group, and MTs Filial Mlinjon represents the low-level school group. The third step, we determined two experiment groups and one control group in each school by randomly selecting three classes from each school. The first experiment groups were taught using STAD cooperative learning model with AFL-based experiment method, the second experiment groups were taught using STAD cooperative learning model without AFL, and the control group were taught using direct instruction model.

Data collection techniques used in this research was the documentation method to obtain the initial students’ mathematics score in the final examination when they were in the second semester of 8th grade. Before the experiment was done, the initial score among the groups was tested for equilibrium by using a one-way ANOVA test with unequal cells. After the experiment, the test was used to obtain students’ mathematics score in solid geometry, and the questionnaire was used to obtain students’ creativity data. The data analysis technique was used two-way ANOVA with the unequal cell after the data normality was tested by using the Lilliefors test and the homogeneity was tested by using the Bartlett test. The post-ANOVA test used a Scheffe test if the results of the ANOVA rejects the null hypothesis.

3. Result and Discussion
The normality and homogeneity test gave a result that the initial ability of each population was normally distributed and homogeneous. Furthermore, we classified the students into high-level creativity (b1), middle-level creativity (b2), and low-level creativity (b3) groups based on the average questionnaire score of student’s creativity with X̄ = 83.22 and the standard deviation of questionnaire score of student’s creativity (s) is 17.79. The students grouped into high creativity if b1 > X̄ + 0.5s = 83.22 + 0.5(17.79) = 92.12. The students grouped into middle creativity if b1 ≥ b2 ≥ X̄ − 0.5s = 83.22 − 0.5(17.79) = 74.33. The students grouped into low creativity if b3 < b2. Based on the range of creativity questionnaire scores, the students, who were given the STAD cooperative learning model using AFL (of 75 students), are categorized as 26 students had high creativity, 25 students had medium creativity, and 24 students had low creativity. The students, who were given the STAD learning model (of 67 students), are categorized as 21 students had high creativity, 21 students had medium creativity, and 25 students had low creativity. While the students who were given a direct instruction (of 68 students), are categorized as 23 students had high creativity, 22 students had moderate creativity, and 23 students had low creativity.

Based on the number of students given the learning model and the creativity of each student, the average score can be calculated. The average score of each cell and the marginal mean of the students learning can be seen in Table 1.
The implementation of impacts,

Therefore, the achievement because the teacher can immediately make improvements by giving effective information to students. Assessment for learning includes students feedback designed to provide immediate, relevant and comparison of mean between rows (learning model) and Scheffe test statistic value is if the test statistic in the critical area. The null hypothesis ($H_0$) is a hypothesis that states there is no difference. The $H_0$ is rejected if the value of the observed test statistic in the critical area. Conversely, if the observed test statistic value is not in the critical area, then $H_0$ is accepted [28]. Based on Table 2, it can be concluded that (1) the learning model impacts the students’ mathematics learning achievement, (2) the students’ creativity influences their mathematics learning achievement, and (3) there is an interaction between students’ learning model and creativity.

From the calculation of the two-way ANOVA with unequal cells, obtained by $H_{0A}$ is rejected, the comparison of mean between rows (learning model) and Scheffe test are shown in Table 3.

Table 3. Inter line double comparative tests (learning models)

| Comparison | $H_0$ | $H_1$ | $F_{obs}$ | $2F_{0.05;2.207}$ | Decision | Different mean |
|------------|-------|-------|-----------|------------------|----------|----------------|
| $\mu_1$ vs $\mu_2$. | $\mu_1 = \mu_2$. | $\mu_1 \neq \mu_2$. | 8.131 | 6.00 | $H_0$ rejected | Significant |
| $\mu_2$ vs $\mu_3$. | $\mu_2 = \mu_3$. | $\mu_1 \neq \mu_3$. | 25.24 | 6.00 | $H_0$ rejected | Significant |
| $\mu_1$ vs $\mu_3$. | $\mu_1 = \mu_3$. | $\mu_2 \neq \mu_3$. | 80.23 | 6.00 | $H_0$ rejected | Significant |

Based on Table 3, it can be concluded that students who got STAD cooperative learning model in their teaching and learning process using AFL possess better learning achievement than those who got STAD cooperative learning model with the experimental method and direct instruction model. The score comparison could also be seen in Figure 1. The implementation of AFL can help students know the mistakes made in learning more quickly. The focus of assessment for learning is increasing students’ achievement [29]. Besides, it shows that the students learn more rather than only listen to the teacher. Some argue that the application of AFL can improve the students learning achievement [17, 18]. Assessment for learning includes students feedback designed to provide immediate, relevant and effective information to students [29]. The application of AFL can improve students learning achievement because the teacher can immediately make improvements by giving feedback to students. Therefore, the errors made by students can be immediately corrected.
In this study, the application of the AFL-based cooperative learning model has better learning achievement than STAD cooperative learning model with the experimental method and the direct instruction model because of the influence of the application of AFL (See Figure 1). It was due to the researchers have carried out the control of the effects of the output variables as much as possible. The steps of study that have been carried out by researchers are (1) providing adequate control by conducting randomization, (2) not artificial means that research results can be generalized into real situations, (3) there is a basis for comparison, since there is a control class, (4) adequate data availability from collected data are spread, (5) data is not contaminated, (6) there is no misleading relevant variable.

The students who get STAD have better learning achievement than who get direct instruction model. In conclusion, STAD was more effective for students’ achievement as compared to traditional method [37]. The effectiveness is because the application of this model helps students in learning the solid geometry material which was originally abstract to be real. Learning through experiment make the material easy to understand and facilitate the students to get meaningful learning experiences. It encourages students to support and help one another in mastering the material taught by the teacher. Also, it helps them to increase interaction actively and positively and to make group members better discussion. So that, they can learn from each other and improve their mathematics achievement in learning. While the application of the experimental method can help students (1) to believe the truth of their conclusion, (2) to collect facts actively, information or data needed through experiments conducted, (3) to fulfil the learning outcomes last longer in their memory, (4) to eliminate verbalism through experiment students have elaborated. Elaborative rehearsal encourages the students to form links between new and prior learning to detect patterns and relationships and construct meaning [14]. Learning with the experimental method in addition to elaborating, it requires students to experiment. Two (of the seven) positive norms for developing mindset by promoting in class are (1) mathematics is about learning and activities, (2) the depth is more important than speed [14]. Through learning by applying the experimental method, students learn by doing and elaborating. They get a deeper understanding, stored longer in the memory, and the material learned is more meaningful and useful for constructing new knowledge by linking the existing knowledge.

From the results of ANOVA calculation, H0b was rejected, and the comparative test was conducted between columns (creativity) using the Scheffe test. A summary of the calculation of the follow-up average between creativity columns is presented in Table 4.
Table 4. The calculation of the follow-up average between creativity columns

| Comparison      | \( H_0 \)   | \( H_1 \)   | \( F_{\text{obs}} \) | \( 2F_{0.05;2;207} \) | Decision | Different mean |
|-----------------|-------------|-------------|----------------------|------------------------|----------|----------------|
| \( \mu_1 \) VS \( \mu_2 \) | \( \mu_1 = \mu_2 \) | \( \mu_1 \neq \mu_2 \) | 10.04                | 6.00                   | \( H_0 \) rejected | Significant |
| \( \mu_2 \) VS \( \mu_3 \) | \( \mu_2 = \mu_3 \) | \( \mu_2 \neq \mu_3 \) | 19.66                | 6.00                   | \( H_0 \) rejected | Significant |
| \( \mu_1 \) VS \( \mu_3 \) | \( \mu_1 = \mu_3 \) | \( \mu_1 \neq \mu_3 \) | 57.33                | 6.00                   | \( H_0 \) rejected | Significant |

Based on Table 4, it can be concluded that the learning achievement of students with a high level of creativity is better than that of students with a medium and low level of creativity. Students with a medium level of creativity are better than those with a low level of creativity. The comparison of the learning result among the creativity groups is illustrated in Figure 2.

![Figure 2](image.png)

**Figure 2.** The average of each category creativity

In Figure 2, the higher the creativity, the higher the score the students could achieve. Critical thinking enhances students’ ideas [30]. Differences in students’ creative thinking abilities are influenced by the way they receive and process information obtained from their learning styles [31]. So, the creativity differences affect the students’ achievement. Moreover, based on the calculation, \( H_{0AB} \) was rejected, the comparison test mean between cells was carried out by the Scheffe method. A summary of the results of the further mean test between cells on the same row is presented in Table 5.

Table 5. The average comparative results between categories of creativity in each learning model

| No | \( H_0 \)   | \( H_1 \)   | \( F_{\text{obs}} \) | \( 2F_{0.05;2;207} \) | Decision | Different mean |
|----|-------------|-------------|----------------------|------------------------|----------|----------------|
| 1  | \( \mu_{11} = \mu_{12} \) | \( \mu_{11} \neq \mu_{12} \) | 33.14                | 24.00                  | \( H_0 \) rejected | Significant |
| 2  | \( \mu_{12} = \mu_{13} \) | \( \mu_{12} \neq \mu_{13} \) | 37.09                | 24.00                  | \( H_0 \) rejected | Significant |
| 3  | \( \mu_{11} = \mu_{13} \) | \( \mu_{11} \neq \mu_{13} \) | 138.15               | 24.00                  | \( H_0 \) rejected | Significant |
| 4  | \( \mu_{21} = \mu_{22} \) | \( \mu_{21} \neq \mu_{22} \) | 0.56                 | 24.00                  | \( H_0 \) accepted | Not Significant |
| 5  | \( \mu_{22} = \mu_{23} \) | \( \mu_{22} \neq \mu_{23} \) | 38.85                | 24.00                  | \( H_0 \) rejected | Significant |
| 6  | \( \mu_{21} = \mu_{23} \) | \( \mu_{21} \neq \mu_{23} \) | 48.62                | 24.00                  | \( H_0 \) rejected | Significant |
| 7  | \( \mu_{31} = \mu_{32} \) | \( \mu_{31} \neq \mu_{32} \) | 7.06                 | 24.00                  | \( H_0 \) accepted | Not Significant |
| 8  | \( \mu_{32} = \mu_{33} \) | \( \mu_{32} \neq \mu_{33} \) | 0.78                 | 24.00                  | \( H_0 \) accepted | Not Significant |
| 9  | \( \mu_{31} = \mu_{33} \) | \( \mu_{31} \neq \mu_{33} \) | 12.53                | 24.00                  | \( H_0 \) accepted | Not Significant |
Based on Table 5, it can be concluded that after using the STAD cooperative learning model with the AFL-based experimental method, students with high creativity level possess better learning achievement than those with medium and low creativity levels. The comparison of the students’ learning achievement is illustrated in Figure 3.

**Figure 3.** The average of each learning model in category creativity

In Figure 3, students with high creativity level possess better learning achievement than those with low creativity level. The application of the STAD model with the AFL-based experimental method conducted by the teacher can increase the students’ creativity level [32]. So, based on the STAD learning model with the AFL-based experimental method, the difference of creativity affects the students’ achievement. In applying the STAD cooperative learning model with the experimental method, the students with high creativity level get similar learning achievement level as the students with middle creativity level. It means that the application of this model can generate the creativity of both students who have high and medium creativity level. Furthermore, students with high creativity level possess better learning achievement than those with low creativity level. So, based on the STAD learning model with the experimental method, the difference of creativity affects the students’ achievement.

In the direct instruction model, students with a high, medium and low level of creativity have not got an equal learning achievement to score, as illustrated in Table 6.

**Table 6.** Summary of average comparison results among learning model for each creativity level

| NO | H<sub>0</sub> | H<sub>1</sub> | F<sub>obs</sub> | 2F<sub>0.05;2:207</sub> | Decision | Different mean |
|----|---------------|---------------|----------------|------------------------|-----------|----------------|
| 1  | µ<sub>1</sub> = µ<sub>2</sub> | µ<sub>1</sub> ≠ µ<sub>2</sub> | 39.55          | 24.00                  | H<sub>0</sub> rejected | Significant |
| 2  | µ<sub>2</sub> = µ<sub>3</sub> | µ<sub>2</sub> ≠ µ<sub>3</sub> | 17.11          | 24.00                  | H<sub>0</sub> accepted | Not Significant |
| 3  | µ<sub>1</sub> = µ<sub>3</sub> | µ<sub>1</sub> ≠ µ<sub>3</sub> | 107.46         | 24.00                  | H<sub>0</sub> rejected | Significant |
| 4  | µ<sub>1</sub> = µ<sub>2</sub> | µ<sub>1</sub> ≠ µ<sub>2</sub> | 1.65           | 24.00                  | H<sub>0</sub> accepted | Not Significant |
| 5  | µ<sub>2</sub> = µ<sub>3</sub> | µ<sub>2</sub> ≠ µ<sub>3</sub> | 36.36          | 24.00                  | H<sub>0</sub> rejected | Significant |
| 6  | µ<sub>1</sub> = µ<sub>3</sub> | µ<sub>1</sub> ≠ µ<sub>3</sub> | 53.27          | 24.00                  | H<sub>0</sub> rejected | Significant |
| 7  | µ<sub>13</sub> = µ<sub>23</sub> | µ<sub>13</sub> ≠ µ<sub>23</sub> | 2.05           | 24.00                  | H<sub>0</sub> accepted | Not Significant |
| 8  | µ<sub>13</sub> = µ<sub>33</sub> | µ<sub>13</sub> ≠ µ<sub>33</sub> | 0.46           | 24.00                  | H<sub>0</sub> accepted | Not Significant |
| 9  | µ<sub>13</sub> = µ<sub>33</sub> | µ<sub>13</sub> ≠ µ<sub>33</sub> | 4.45           | 24.00                  | H<sub>0</sub> accepted | Not Significant |
The not significant of learning achievement was because the students were only getting information and memorize the material delivered by the teacher. They tend to be passive. Students’ creative thinking skills cannot be well-developed if the teacher does not actively involve students in the learning process [33, 34]. So that students with high, medium and low creativity levels possess similar levels on their learning achievements score. So, based on direct instruction, the difference of the creativity doesn’t affect the students’ achievement. The comparison of the data is illustrated in Figure 4.

Figure 4. The average of each category creativity in the learning model

In Figure 4, the students with high creativity level when applying STAD cooperative learning model with AFL-based experimental method have better learning achievement than those exposed to STAD cooperative learning model with the experimental method and direct learning models. Meanwhile, students who are exposed to STAD learning model with experiment have Learning achievements that are as good as students exposed to the direct instruction model. It means that the feedback on AFL serves to provide feedback to students about things that they have not been understood. To find out the material that has not been experienced by students, the teacher can give questions to the students. Therefore, the question as a part of the teaching tools is a good strategy for motivating and challenging students’ thinking, so that interaction can occur in the learning process [35]. So, in high-level creativity, the learning model affect the student’s achievement.

Students with medium creativity level exposed to STAD cooperative learning model with AFL have a learning achievement that is as good as those exposed to STAD cooperative learning model with the experimental method. Meanwhile, students who get STAD cooperative learning model with AFL and STAD cooperative learning model with experimental method have better mathematics achievement score than those who get direct learning model. It means that the implementation of STAD cooperative learning is an active learning strategy [36]. STAD is a cooperative-learning strategy in which small groups of learners with different levels of ability work together to accomplish a shared learning goal [37]. The important fact is that creativity can be developed and everyone has the potential to be creative [38]. Creativity is needed to learn solid geometry, as it is in line with constructivism [39]. The application of the experimental method can enhance students’ creativity. So, in middle level creativity, the learning model affect the student’s achievement.

Students with low creativity level who get STAD cooperative learning model with the AFL-based experimental method and who get STAD cooperative learning model with the experimental method and direct instruction model gives an equal low mathematics achievement score. It means that students with low creativity level could not improve their achievement after being exposed to different learning
models. They tend to be passive in the learning activities. Thus, in low-level creativity, the learning model doesn’t affect the student’s achievement.

4. Conclusion
Based on the study results, it can be concluded that; first, students’ learning achievement in mathematics learning with STAD cooperative learning model with AFL-based experimental method is better than STAD cooperative learning model with experimental method and direct instruction model, the students’ achievement with STAD cooperative learning model with experimental method is better than with direct instruction model. Meanwhile, students with high creativity level have better learning achievement than those with medium and low creativity levels. The students with medium creativity level have better learning achievement score than the students with low creativity level. Thus, there are interactions between the learning model with creativity in increasing mathematics learning achievement.

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